# Knowledge.

With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News.

A Monthly Record of Science.

Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

DECEMBER, 1914.

## METEOR ORBITS.

By THE REV. M. DAVIDSON, B.A., M.Sc., F.R.A.S.

THE discovery of the relationship between comets and meteors may now be considered as one of the established truths of astronomy. Our periodic meteors are the *débris* of ancient comets, now largely disintegrated, whose material has become distributed around their orbits. When the Earth in its annual path passes through a portion of this *débris*, the particles are ignited by friction with our atmosphere, and a shower of meteors is the result. The question of the origin and nature of the cosmical clouds which finally give rise to meteors, whether materials expelled from some distant stars or fragments of matter escaping absorption into larger bodies, is one beyond the limits of this present article. We shall assume the existence of these in stellar space, and proceed to show how it may be possible for them to suffer a certain amount of disintegration, so that finally a meteor stream is the result.

Let us assume a number of particles, of uniform mass and density, equally distributed in a certain space, and the average distance between any two $2a$. If we imagine a large number of such bodies forming a sphere of unconsolidated matter, the attraction at the surface of this sphere can be represented by $\frac{\Sigma m}{r^2}$, $r$ being the radius of the sphere. The number of particles is $\frac{r^3}{a^3}$, so that $\Sigma m = m\,\frac{r^3}{a^3}$. Hence the attraction at the surface is $m\,\frac{r}{a^3}$.

Now let us assume that the centre of such a sphere moves to a point distant R from the centre of the Sun. The attraction of the latter on the near side is $\frac{M}{(R-r)^2}$, and on the centre $\frac{M}{R^2}$; the difference is $\frac{M\,(2Rr-r^2)}{R^4-2rR^3+R^2r^2}$. If $r$ is small compared with R, this reduces to $2M\,\frac{r}{R^3}$. If disintegration is to occur, then $2M\,\frac{r}{R^3} > m\,\frac{r}{a^3}$, or $\frac{2M}{R^3} > \frac{m}{a^3}$.

Suppose we take R to be one astronomical unit and $2a$ to be six feet. Substituting the values for M and R, we easily find that $m$ cannot be less than sixteen grains, if disintegration is not to ensue. This example will show how a nebulous mass may be broken up by the action of the Sun.

There is another way in which disintegration can occur. It is now known that light-waves exert a pressure upon objects on which they fall. It was pointed out by Maxwell in 1873 that this should take place in accordance with his electromagnetic theory. In 1900 Professor Lebedew announced that he had isolated and measured the light-force, and other physicists followed with various experiments, which firmly established the existence of radiation pressure. While this pressure is very small, it is yet able to exercise an appreciable influence upon minute bodies. Thus the Earth



XUM

experiences a pressure of about seventy-five thousand tons; but since the ratio of light-pressure to gravitation pull increases as the linear dimensions decrease, a point is reached at which the former prevails. This can only take place when the particles are very small—about the thousandth part of a millimetre in diameter.

Professor Poynting has taken the case of a dark particle of density 5·5, and the thousandth of an inch in diameter. Under these circumstances he shows that the radiation pressure is about one hundredth of the pull exercised by the Sun, and the periodic time of such a particle would be increased from three hundred and sixty-five and one quarter days (assuming its original period the same as that of our Earth) to about three hundred and sixty-seven days. Again, there is heat radiated by such a particle, and the radiation pressure is greater on the front than on the rear, for the frequency of the vibrations is raised in accordance with Doppler's principle; hence the particle tends to spiral inwards towards the Sun. Thus, as Professor Poynting shows, "a comet of particles of mixed sizes will gradually be degraded from a compact cloud into a diffused trail lengthening and broadening, the finer dust on the inner and the coarser on the outer edge."

If we take the case of a meteor stream where the particles have been drawn out along its track, an orbit originally elliptical will tend to become circular through the Doppler effect. Hence there seems the possibility of certain streams which once lay outside the orbit of the Earth being drawn in; and if they encounter the Earth new meteor radiants are observed.

There are ancient records of comets which were seen to break up into fragments. Thus Seneca relates that Ephoras mentions a comet which divided into two portions before disappearing. In 1618 two comets appeared in the same part of the heavens, and were probably fragments of a comet that had broken up. In the winter of 1845–6 Biela's comet separated into two parts, and these two distinct portions were visible when it returned to the Sun in 1852. As the comet did not appear in 1865 and in 1872, a meteoric shower was expected from its *débris* about November 27th, this being the date when the Earth would encounter its fragments. The display of shooting stars on November 27th, 1872, was remarkable, and on comparing the orbit of the stream, deduced from a knowledge of the radiant, with that of Biela's comet, the two were found to be practically identical. The elements of each are given at the end of this article, their similarity being apparent.

We shall now consider the case of a few other meteor streams. On January 2nd and 3rd there is a shower from a point in the heavens near R.A. 15h 20m, Declination 52° N. This shower was seen last year by Mr. C. L. Brook, Meltham, Yorkshire, and by Mr. Denning, of Bristol. The present writer worked out an orbit, the elements of which are given at the end, and also made a model of their orbit and that of the Earth. These are shown in the first figure, where it will be seen that the Quadrantids move with a great inclination to the plane of the ecliptic, and also that the Earth intersects the stream very close to its perihelion, P. No comet is known which corresponds with this shower: it is probably the remains of one long since disintegrated (see Figure 397).

The Leonids are most active on November 13th and 14th, and were seen last year by some members of the British Astronomical Association, including Miss A. G. Cook (Stowmarket) and Mr. and Mrs. Wilson (Bexley Heath); they were also seen at the Royal Observatory, Greenwich. The radiant for this shower is at R.A. 10h, Declination 23° N. The model shows the orbit, and the connection between the Leonids and Tempel's comet is obvious by comparing their elements. This shower was very active on November 14th, 1833, and ten returns of the same shower were found on enquiry to have occurred before 1799. The fact that the great displays had taken place at intervals of about thirty-three years, or some multiple of this period, led to an expectation of a brilliant shower in 1866. It recurred with considerable brilliancy, though less than in 1833. The particles composing this stream are concentrated at one portion of its orbit, and our Earth encounters this part every thirty-three or thirty-four years, unless it suffers considerable perturbations from Jupiter, as in 1899. The particles are also drawn out along the orbit, though they must be greatly scattered, as the shower is not abnormally rich in ordinary years (see Figure 398).

The Geminids are active about the middle of December. Last year a shower was observed by Mrs. Wilson, a well-known astronomical worker. The radiant was near $\beta$ Geminorum. It will be seen from the photograph of the model that the particles composing this stream pass near the Sun at perihelion, their distance being under two millions of miles. There is no comet whose orbit corresponds with that of the Geminids (see Figure 396).

Other important showers may be mentioned, such as the Lyrids, whose orbit is like that of the first comet of 1861, though it cannot be definitely established that they are the *débris* of this comet. The Perseids are identified with the third comet of 1862, known as Tuttle's. The elements of these two orbits are nearly the same (see No. 6 of the list).

Enough has been said to show that there are many interesting problems opened up in connection with meteoric astronomy, and a fruitful field of work is open to those who have the time and inclination for this particular sphere.

The elements of the orbits of some meteor streams, and also of comets, are given below.

XUM

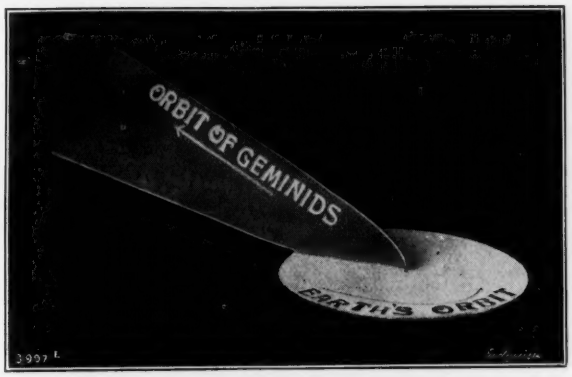



FIGURE 396.

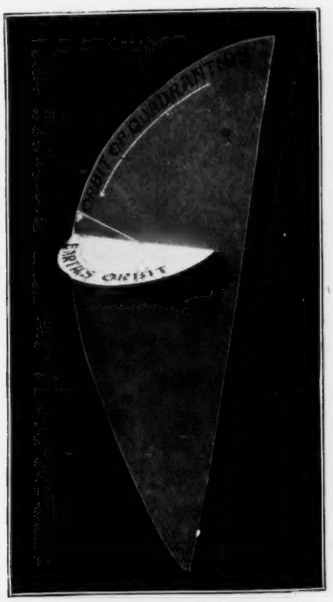



FIGURE 397.

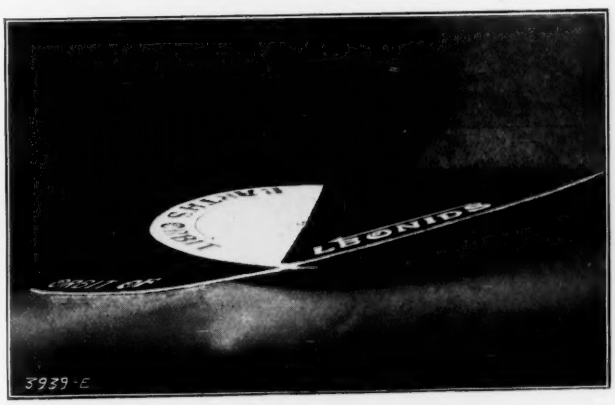
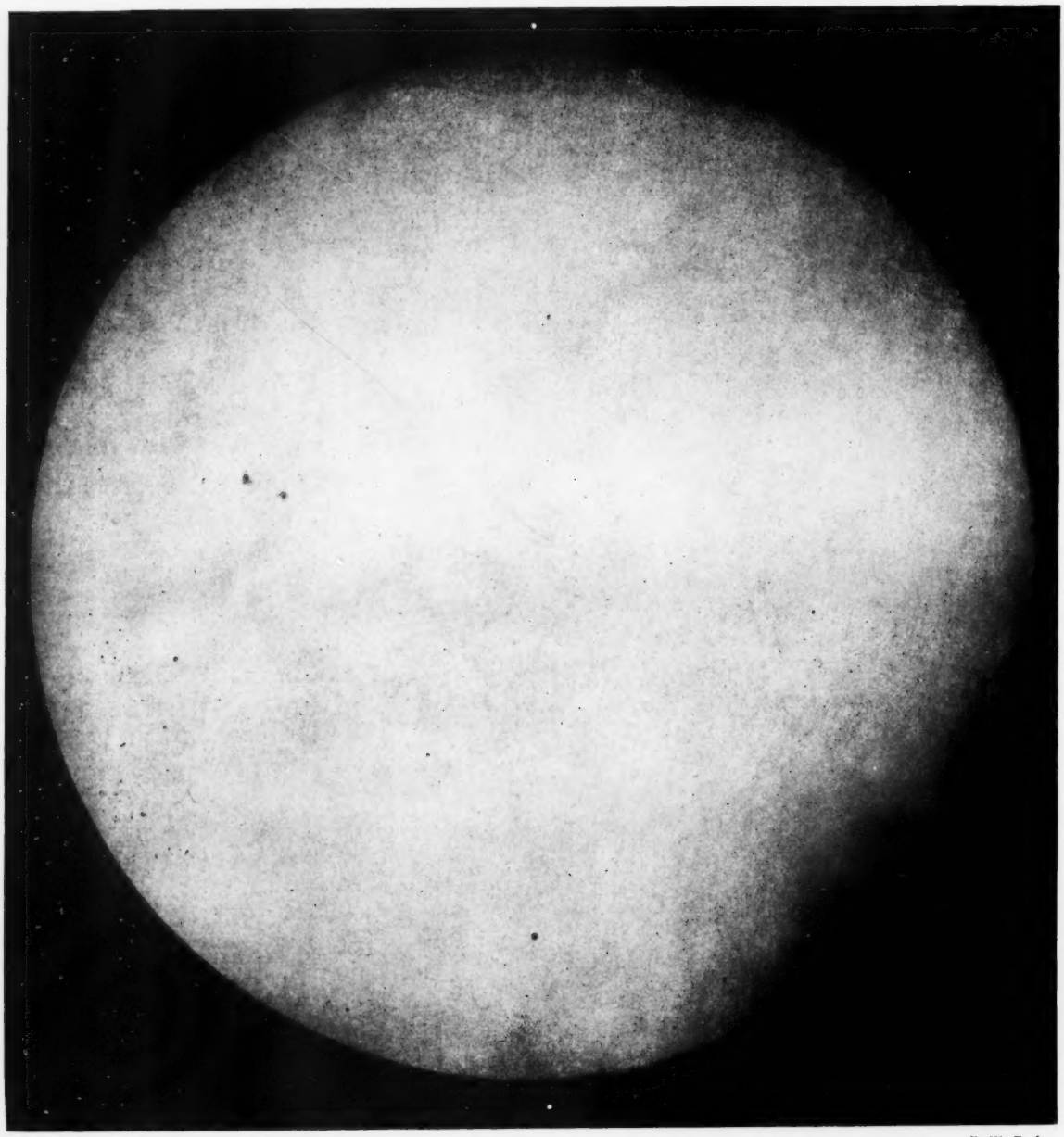



FIGURE 398.



*From a photograph by* *F. W. Barlow.*

FIGURE 399. Transit of Mercury, November 7th, 1914.

The North and South points of the Sun are indicated by the white dots.

(See page 419).

METEOR STREAMS.

| No. | Radiant. | $\iota$ | $\pi$ | ☊ | $\underline{9}$ | Shower. |
|---|---|---|---|---|---|---|
| | ° ° | ° | ° | ° | | |
| 1. | 232+51 | 72·8 | 96·2 | 282 | ·981 | Quadrantids |
| 2. | 149+22 | 164·6 | 47·5 | 232 | ·986 | Leonids |
| 3. | 117+28 | 58·2 | 244·8 | 261·4 | ·021 | Geminids |
| 4. | 24+45 | 17 | 110 | 244 | ·836 | Andromedids |
| 5. | 272+33 | 79 | 248 | 32·5 | ·912 | Lyrids |
| 6. | 45+57 | 114 | 291 | 138 | ·964 | Perseids |

The symbols have the usual significance :—

$\iota$ denotes the inclination to the plane of the ecliptic.

$\pi$ denotes the longitude of perihelion.

☊ denotes the longitude of the ascending node.

$\underline{9}$ denotes perihelion distance in astronomica units.

Nos. 2, 4, 5, and 6 meteor streams correspond with comets Nos. 2, 4, 5, and 6 respectively.

COMETS.

| No. | | $\iota$ | $\pi$ | ☊ | $\underline{9}$ | Comet. |
|---|---|---|---|---|---|---|
| | | ° | ° | ° | | |
| 2. | ... ... | 162·7 | 60 | 231·5 | ·976 | Tempel |
| 4. | ... ... | 12·5 | 109·1 | 245·8 | ·860 | Biela |
| 5. | ... ... | 79·75 | 243·4 | 29·9 | ·921 | 1861, I |
| 6. | ... ... | 114·3 | 291·5 | 138·6 | ·957 | 1862, III |

The Figures have been reproduced by kind permission of the Council of the British Astronomical Association.

## CORRESPONDENCE.

### RUSSIAN PEASANTS' ARITHMETIC.

*To the Editors of* "KNOWLEDGE."

SIRS,—The following proof may be given of the Russian mode of multiplication mentioned in your June issue.

Every number is of the form $2^{p_1} + 2^{p_2} + \ldots + 2^{p_n}$, the indices being in descending order of magnitude, and $p_n$ may be zero. Let the numbers to be multiplied be

$$a \text{ and } 2^{p_1} + 2^{p_2} + \ldots + 2^{p_n}.$$

The product is, of course,

$$a(2^{p_1} + 2^{p_2} + \ldots 2^{p_n}).$$

Multiply $a$ successively by 2 and divide the other number similarly by $p_n$ times ; we get

$$a \times 2^{p_n} \text{ and } 2^{p_1 - p_n} + 2^{p_2 - p_n} + \ldots + 2^{p_{n-1} - p_n} + 1.$$

The right hand is odd, all the intermediate quotients being even.

Reject the 1 and multiply and divide by 2 as before $p_{n-1} - p_n$ times ; we get

$$a \times 2^{p_n - 1} \text{ and } 2^{p_1 - p_{n-1}} + 2^{p_2 - p_{n-1}} + \ldots + 2^{p_{n-2} - p_{n-1}} + 1.$$

As before, the right hand is odd, the intermediate quotients being all even.

Reject the 1 and multiply and divide by $2^{p_{n-2} - p_{n-1}}$, and so on. Adding the left-hand products we get the final result as above.

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NORWICH.

*To the Editors of* "KNOWLEDGE."

SIRS,—The explanation of the method used by Russian peasants for the multiplication of two numbers is as follows :

First, it is evident that, in a product which results from the multiplication of two factors, if the one be halved and the other doubled, the product is unaffected ; what is lost by the one is gained by the other. In the process under discussion, therefore, if the left-hand factor be even, the net result of the immediately following operation upon the product is nil. If the left-hand factor be odd, the immediately subsequent operation results in a product which is less than the original required product by once the right-hand factor. In the final addition this loss is made good by the reïnclusion of any number in the right-hand column which stands opposite to any such odd factor in the left-hand column.

To take a concrete example, say the first of those given by your correspondent :—

$25 \times 11$ .....(1)
$12 \times 22$ .....(2)
$6 \times 44$ .....(3)
$3 \times 88$ .....(4)
$1 \times 176$.....(5)

Line 2 is the original product (line 1) less the odd (25th) eleven, the first 24 elevens being equivalent to the 12 twenty-twos of line 2.

Line 3 is the exact equivalent of line 2, which may therefore be crossed out, line 3 being left in its place.

Line 4 is the exact equivalent of line 3, which may therefore be crossed out.

Line 5 is the equivalent of line 4, less the odd (3rd) eighty-eight : this is itself the equivalent of line 1 (the required product) less 11.

Hence the required product is line 5+88+11.

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## THE TRANSIT OF MERCURY, NOVEMBER 7TH, 1914.

FIGURE 399 is from a photograph which was taken at Bournemouth with a 4¾-in. refracting telescope with camera attachment, the exposure being about one-thirtieth of a second, a lantern plate being used as negative, and yellow screens employed to reduce the intensity of the light. Save just at the beginning of the transit, the Sun was never quite free from cloud, very light cirri at first, and gradually getting thicker, the definition being consequently only moderate. In the telescope at the moments of best definition the planet appeared quite sharply defined and clear-cut against the mottling of the solar granulation. There was no light-halo round the planet or any light-spots on it such as have sometimes been recorded. The "black drop" was seen for a few seconds at egress, definition being then good, in spite of fairly thick cloud. The obscuration of part of the Sun's edge in the photograph is due to cloud. In comparing the relative sizes of the Sun and Mercury it must be remembered that the planet is considerably nearer us than the Sun is, and therefore looks proportionately larger. Two small spot-groups are visible.

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XUM

# THE SPINNING OF A WEB.

By FRANK CUTTRISS.

A HEAVY thunderstorm in the afternoon having completely destroyed and washed away every trace of the web which a half-grown female garden spider had made amongst the pines on the previous day—night, we should perhaps say, as we had arrived on the scene at midnight, just as she was completing it—we considered the circumstances favourable for carrying out a project we had long had in mind, that of watching the construction of a spider's geometrical web from start to finish.

By early evening the storm had passed, leaving the earth sodden, and the pine foliage sparkling with innumerable raindrops; thunder rumbled all around, while the clouds were still very heavy and threatening, and we were a little doubtful if the weather would permit us to keep our vigil.

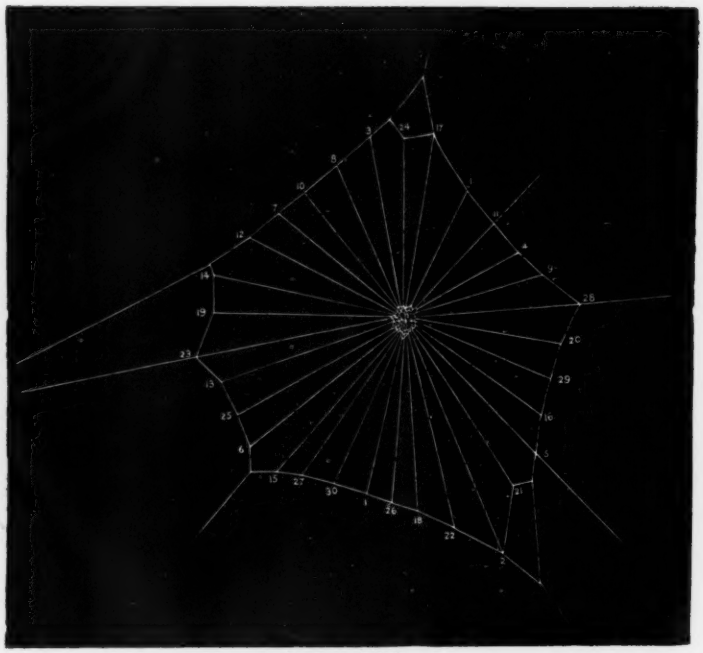

FIGURE 400.

Diagram showing the order the radial lines of the web were fixed.

At seven o'clock the spider lay close to the underside of the branch which it had chosen for its home. One could fancy it had foreseen the occurrence of storms, for no more perfect shelter could be imagined, the branch keeping off direct rain and the foliage around conducting all water away from the spider.

At half-past seven, at eight o'clock and half-past eight, when we visited it, no movement had occurred, and it appeared as though our trouble would be unrewarded.

We felt certain, however, that if it were likely to remain fine all night, with the prospect of a fine morning, the spider would appreciate it, and, by about midnight, construct a new web for the morrow.

Nine o'clock came, and, although the clouds were as dense and stormy-looking as ever, we decided to visit our friend again and see what it was thinking. This time we were rewarded, for just as we reached the spot it left shelter, came out to the tips of the foliage, dropped down a line to a point a few inches below, ascended to about midway, turned head downward, and remained suspended for about fifteen minutes (see Figure 401). It then ascended to its nest branch, and in a few minutes descended to a branch below. Five seconds later it ascended to its original position, taking up the line with it, so that at 9.25 p.m. practically nothing visible had been done.

Ten minutes later it again emerged, descended to a branch below, and made fast a line, which eventually formed two of the perpendicularly radiating lines. Ostensibly, therefore, the spider commenced the real business of making its web at 9.35 p.m. Next, from the tips of the foliage of its nest branch it let loose a long line with a free end, the object of which soon became apparent; for in a few seconds it became attached, at an angle of about forty degrees, to foliage on the lower left hand. Here the instinct—or reason—of the animal especially arrested our attention, as at the time the wind was blowing from the right, directly in line with the position selected for the web, so that in very few seconds the floating thread streamed out and was caught as described. Practically from no other point than that chosen by the spider for setting loose this line could the end in view have been attained.

We now conjectured a speedy completion of the structure, mentally allowing about an hour for the work. We reckoned, however, without our entertainer, for after having done a certain amount of groping about among the foliage in the vicinity

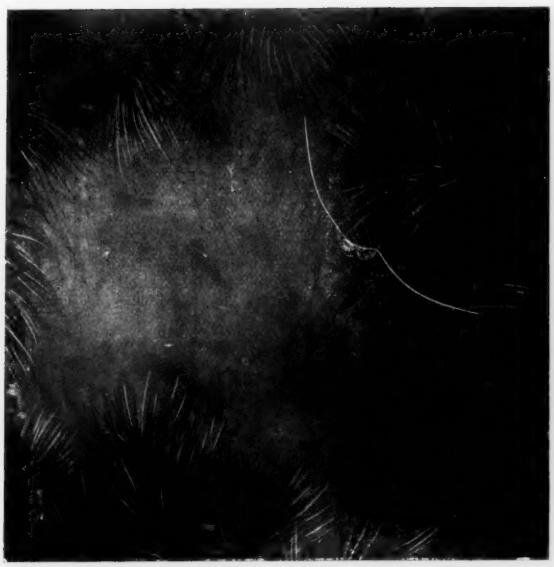

FIGURE 401. 9.0 p.m.

FIGURE 403. 10.30 p.m.

FIGURE 402. 9.50 p.m.

FIGURE 404. Midnight.

XUM

FIGURE 405. 12.30 a.m.

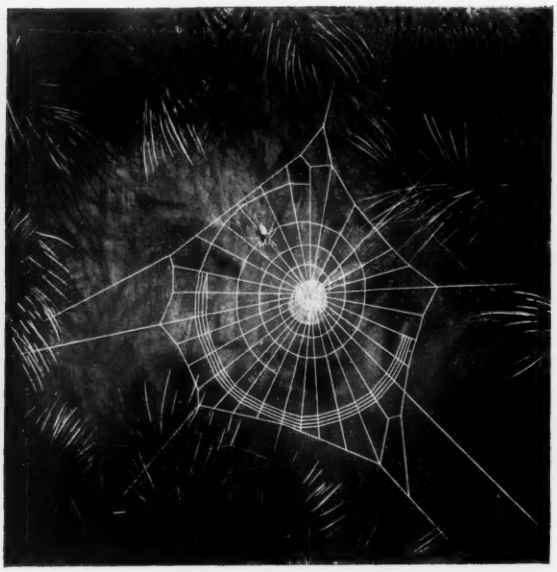

FIGURE 407. 12.50 a.m.

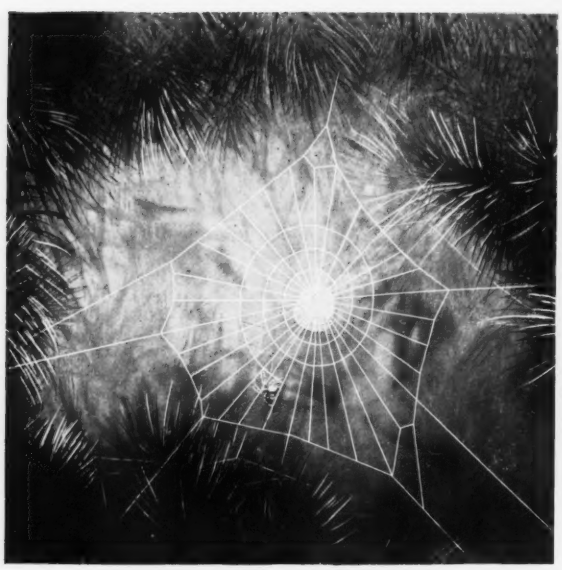

FIGURE 406. 12.40 a.m.

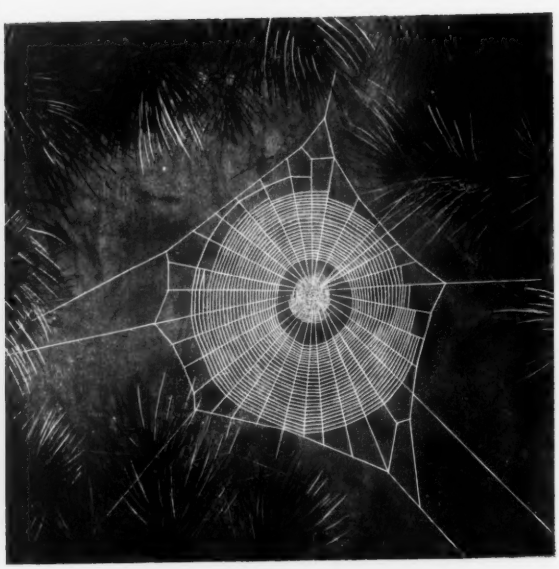

FIGURE 408. 1.25 a.m.

the net result at 9.50 (see Figure 402) was a rough framework, two upper and two lower lines radiating from a nebulous sort of ring, which was evidently determined upon as the centre for the coming web. The architect now settled herself comfortably, head downward, at the junction, and took a long rest. Twenty minutes elapsed, and our spinner appeared suddenly to realise that time was going on, and set to work again, until at 10.27 p.m. most of the supports were fixed, and nine of the radiating lines were in position (see Figure 403). The spider now ascended to the nest branch, and for a considerable time crept about amongst the foliage. At 11.10 p.m. it descended to the centre, and remained there, head downward, for five minutes; at 11.15 it was again stirring, until at 11.37 the right-hand support or border line had been fixed as well as twenty-two of the radial threads. The twenty-seventh radius was fixed at 12.3 a.m., after which the spider returned to the centre and remained head downward (see Figure 404).

In every case where we say rested or remained in centre of web, or elsewhere, we do not wish to convey the idea that the spider did absolutely nothing during the time, although for the most part no movement was noticeable.

At 12.30 a.m. (see Figure 405) the last of the thirty-one radial threads was in position, the accompanying numbered diagram showing at a glance the order in which they were made (see Figure 400). A short space of time between the placing of all the radii after the twenty-seventh was devoted to netting together at centre and fixing roughly concentric threads over larger or smaller segments, which the little creature accomplished by travelling to and fro, stopping momentarily to fix the thread as it went, the greater part of the central work being done after the fixing of the twenty-ninth radial.

A few seconds after this the spider commenced one of the most wonderful of the many astonishing features of geometric web-spinning, inasmuch as it apparently demonstrates foresight and the possession by the spider of reasoning powers which enable it to use the best means to accomplish the end in view. It affixed a thread near the right upper centre, then by supporting itself on the radial threads and working towards the left it affixed its thread—always one remove back—in a beautiful volute of about two and three-quarter turns, which was completed at 12.40 a.m. (see Figure 406).

The objects of this helical line, it afterwards became evident, were to keep the radiating threads properly taut and at the intended distances apart; also to some extent as a scaffold for the construction of the concentric portion of the web.

At 12.41 a.m. the outermost of the concentric threads was placed by the spider, working from the top towards the left, and upon arriving at the intended limit on the right it turned about and commenced the second thread, working towards the left by way of the bottom of the web.

At 12.48 a.m. four of these threads had been fixed, the spider accomplishing the work by climbing up two threads ahead, descending to just the right distance from the thread last fixed, bending its abdomen over the radius next to it, making a decided pause, and with the spinnerets getting the thread, which had exuded as it proceeded, fixed at exactly the right spot, holding the section just fixed with the hind foot on that side so that it should bear the strain during the operation; then up the next radius, and so on, over and over again (see Figure 407).

Given a good illumination through the web, the most superficial observer would by this time have noticed that a very short time after each division of a concentric was fixed, it changed in appearance from the finest streak of reflected light to an apparently stouter and whiter line, and would recollect that none of the other lines—supports, radii, or central netting—underwent any such change. Upon closer examination and magnification this would be found to be caused by the running together into globules of a viscid matter, the result probably of the spider intentionally bringing into action a special secretion. We carefully noted the time elapsing between the fixing of a thread and the completion of the studding with viscid globules, and found it in every case to be exactly fifty seconds.

The spider now kept on steadily at work, the only variation in its movements occurring with the completely circular threads, all of which were fixed by the spider working in one direction only (from left to right) instead of turning about as at the end of an incomplete circle and working the next in the opposite direction.

Excepting when descending on a line, the spider appeared in every case to draw out the thread from its spinnerets by means of its hinder feet used alternately, while the temporary volute or helical thread was cut away, apparently by its fore feet, as the spider reached it in fixing the permanent concentric lines.

At 1.25 a.m. the finishing touch was given to one of the most perfect webs we have seen (see Figure 408), and the little wonder-worker glided up a line connected with the intricate network in the centre and took up its position to watch and wait on the underside of the branch, the shelter of which it had left nearly four and a half hours earlier.

The web constructed by this spider on the previous night—preceding the storm—had two stay lines attached, one on either side near the centre, which were affixed to the foliage about four or five inches away.

The web we saw constructed had no stay lines, the succeeding day being calm and without rain. We noted these facts incidentally, but would consider it unwise in the absence of recurring confirmatory observations to attribute them to either premonition or coincidence.

In connection with the construction of geometrical

XUM

webs it is interesting to note that, although the foregoing spider on three consecutive days made webs, each of which contained the same number (thirty-one) of radii, there appears to be nothing to determine the number of these radiating lines that any particular spider will make. Perhaps we ought rather to say that the factors determining such are at present beyond our knowledge.

An *Aranea umbratica* which we had under observation at the same time as our friend *diademata* constructed—also at midnight—a web twelve inches in diameter. This, while much larger than that of the garden spider, was much more open in structure—a characteristic of this species—and contained twenty-two radii only, which at the outside of the web were necessarily so much further apart than those of *diademata* as to render it difficult to construct the outermost concentric threads. To obviate this difficulty the spider made a temporary helical line of six coils instead of the three, which, extending much nearer to the outer edge, enabled the spider to use it comfortably as a scaffold to get on to the next radius, along which it slipped foot after foot, precisely in the manner of a tit descending a cord, until in position for affixing its thread.

Again, the web of a *Zilla notata*, six inches only in diameter, had forty radiating threads, while a younger spider of the same species constructed a web, containing but twenty, across the mouth of a jug.

A vast field for research in this direction is open, and, although there is evidence of increasing interest in the ways of the much-maligned spider, it would seem that the fringe only of the subject has been touched, and it may well be said of it, as of everything else in Nature, that he who knows most concerning it knows best how little he knows.

## SOME INTERESTING GRAFTS.

IT is now common knowledge that the celebrated firm of James Veitch & Sons, to the enterprise of which horticulture owes many plants of which the names are now household words, is to come to an end. It is perhaps a wise decision of Sir Harry Veitch that, if it is not to be carried on by a member of the family, it were best that business should cease to exist. We are reminded that the firm in question, some years ago, made a series of experiments in grafting, at the suggestion of the late Professor Romanes, with a view to seeing whether any effects could be noted of stock upon scion, or scion upon stock. The plants chosen were woody ones, and the results were practically nil, though a very interesting series of combinations was produced and preserved at Coombe Hill Nurseries. Some of these are shown in the reproductions of photographs from which Figures 409 to 414 were taken.

## THE TRANSIT OF MERCURY.

THE transit of Mercury was observed here with various telescopes, both visually and photographically. The seeing was unusually good, and the planet was seen at ingress by the writer on the focusing screen of an astro-camera to show a marked "black drop" effect. There was no difficulty in perceiving this, as the planet's image was about one-eighth-inch in diameter on the screen, which received the image from a 0·9-in. Hughenian eyepiece, used as a projector on the ten-inch Cooke refractor.

There was no halo round the planet when carefully scrutinised. It is probable that the reputed halo is an illusion. With a two and three-eighth-inch Steinheil telescope the writer saw it to-day as he did also in 1907 with the same instrument and eyepiece at the University Observatory, Oxford.

Careful scrutiny with the ten-inch refractor and powers 180 and 300 failed to reveal it, and also failed to show any markings whatever on the planet, which, whenever well seen, appeared as a perfectly round, sharp black disc on the Sun. At egress the weather was misty; the disc, therefore, was suffused with a veil of sunlight, which was uniform, and evidently due to sky-glare. At egress the disc was distorted with the "black drop" phenomena, which, however, were both less marked and more difficult to see than at ingress, owing to lack of transparency. The seeing at times was as high as 6 on a scale 10, which is exceptionally good for daytime. The limb of the Sun was not as sharply defined as that of Mercury.

These observations provide conclusive, if negative, evidence about the reputed halos and white spots which have been reported on some former occasions.

About a dozen photographs were attempted. The most successful are, perhaps, those obtained with the ten-inch telescope, twelve-foot focus, with an eyepiece used as projector, giving an equivalent focus of about one hundred and eighty feet. But these lack definition, owing to the state of the atmosphere, and also to difficulties of focusing the visual combination. Other photographs with five-inch and one and a quarter-inch Sun also show the planet; but by far the most satisfactory view was obtained visually. In these observations Messrs. Bryant Baker, Robert Baker, W. H. Steavenson, and J. E. Maxwell assisted, and in these conclusions they concurred with the writer.

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Four Marks Observatory,
Alton, Hants.

## *THE GAZETTE ASTRONOMIQUE.*

IT is proposed to recommence the publication of the *Gazette Astronomique*, formerly issued by the Astronomical Society of Antwerp. The occupation of that town by the Germans occasioned the temporary suspension of the *Gazette*, and many of its supporters have now found hospitable homes in this country. A number of English astronomers, on the initiative of Mrs. Fiammetta Wilson, of Bexley Heath, are interesting themselves in the matter by financial assistance and the promise of literary contributions.

It is intended to restart the *Gazette Astronomique* early in January in the French and English languages. The minimum subscription will be five shillings annually, but English astronomers who are able and willing to subscribe more liberally may send half a guinea or a guinea as a means of more effectively aiding their unfortunate allies in the attempt to revive their astronomical journal. It will be issued once a month, unless circumstances should enable it to appear more frequently. Subscriptions and correspondence should be sent to Félix de Roy, Honorary Secretary, 29, Stamford Street, London, S.E.

FIGURE 409. Grafting in the family Oleaceae.
In the left-hand specimen the stock is *Osmanthus*, and the scion *Phillyrea*. The right-hand specimen is Privet (*Ligustrum*) on *Phillyrea*.

FIGURE 410. *Eriobotrya* grafted on *Raphiolepis* (family Rosaceae).

FIGURE 411. The plants joined together here belong to the same family as those shown in Figure 409, namely, Oleaceae. They are *Phillyrea* grafted upon *Olea olicifolia*.

FIGURE 412. The Rose grafted on the Bramble (family Rosaceae).

FIGURE 413. This example shows two conifers grafted together. *Thuiopsis* on *Biota*.

FIGURE 414. The examples shown are Garraya and the spotted laurel (*Aucuba*—family Cornaceae).
In the left-hand specimen the latter is the stock, in the right-hand one it is the scion.

The specimens shown in Figures 409 to 414 were grafted by Messrs. James Veitch & Sons some years ago at the suggestion of the late Professor Romanes, and they have been grown at Coombe Hill Nurseries. (See page 424.)

XUM

FIGURE 415. a. A secondary wing feather of an African Ground Hornbill. A longitudinal section has been made of the shaft, so that it is seen to be hollow throughout its length.
b and c. Portions of another feather seen from above and below with the shaft obliquely cut through.

FIGURE 416. A primary wing feather of a Condor. In this the shaft has been laid open: above the quill it is shown to be solid and filled with a white pith-like substance.

## FEATHERS WITH HOLLOW SHAFTS.

THE study of feathers is an interesting one, though there are few who take it up. In preparing a series of feathers for exhibition, illustrating their more interesting modifications, the writer made what he thinks is a little discovery. In all the textbooks the shaft, or rachis, of the feather is described as being solid. If one cuts through, say, the wing-feather of a goose, one finds that immediately above the hollow quill the feather is filled with a white pith-like substance. When examining the feathers of an African Ground Hornbill, it was found that the whole shaft, from quill to the tip, even in the long-flight feathers, was hollow. In Figure 415 this is well shown, and Figure 416 represents a Condor's feather, of which a section has been made for comparison. Although many hundreds of kinds of feathers have been examined, a similar state of affairs has not been found in any others, except in the American Darter. There appear to be a small tube in the shaft of the Secretary Bird's wing-feather and a slight indication of one in one or two others. It would be interesting to hear whether our readers can throw any further light on the subject.

WILFRED MARK WEBB.

## SOLAR DISTURBANCES DURING OCTOBER, 1914.

By FRANK C. DENNETT.

IT was found possible to observe the Sun every day during October. On six days (2nd, 6th, 13th to 16th) the disc appeared free from disturbance; only faculae were visible on nine others (3rd to 5th, 7th to 9th, 12th, 17th, and 18th), spots being seen on the remaining sixteen, though none were of great magnitude. The longitude of the central meridian at noon on October 1st was 223° 50′.

No. 31, belonging to the September list, remaining visible until October 1st, reappears on the present chart.

No. 32.—A group of four pores, the largest being the leader, some fifty thousand miles in length, was noticed on the 10th; but only two remained the next day, when it was last seen. The region was marked by faculae on October 1st, 12th, and 29th.

No. 33.—A small spot, with four tiny pores nestled closely behind it. The whole group, not more than fifteen thousand miles in length, was seen on the 19th at 10 a.m. At 1.30 p.m. the spot contained two umbrae, and only two of the pores remained. On the 20th the spot was elongated, with six pores following it. When last seen on the 21st there were two pores leading in place of the spot and one at the rear. The area was marked by faculae on the 24th and 26th.

No. 34.—Two spotlets on the 22nd, perhaps five thousand miles in diameter, with pores between, some forty-two thousand miles from end to end. Next day the preceding umbra had become crescent-shaped, with a tiny black dot ahead like a Turkish crescent and star; a tiny pore south-east of the following spotlet slightly increased the length of the group. By the 26th it had assumed the form shown on the chart, with a length of sixty-seven thousand miles. Slight changes were noted on the two succeeding days, and when last seen on the 29th it consisted of one spotlet with three pores in front of it.

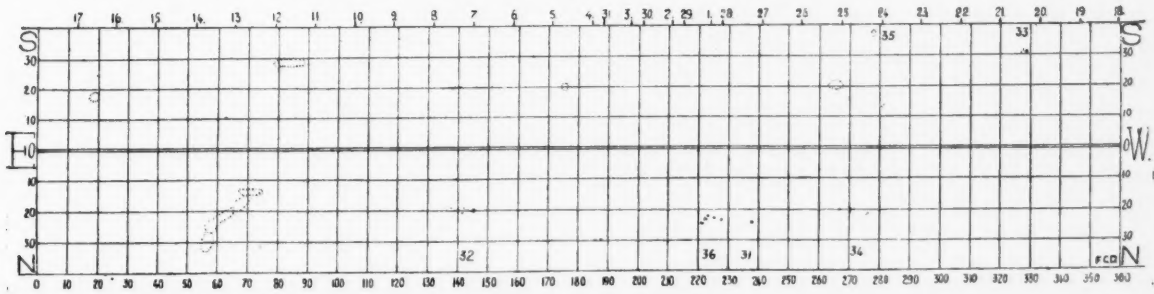
No. 35.—A pair of pores only seen on October 26th.

No. 36.—When first seen on the 26th there were four pores, a larger one with three smaller; the group nineteen was thousand miles in length. By next day the group had grown to about seventy thousand miles in length, consisting of pores, the one small spot being near the middle of its length on the northern side. The chart shows it on the 29th, but next day the rear component was enlarged. On November 1st two spots were visible, each having a pore behind it. Last seen as a spot with a faculic cloud lying to the north-east on the 3rd.

Faculae were recorded near the limb west or *preceding* on October 3rd; north-west on 4th, 5th, 17th, 18th (long. 70°, N. lat. 24°) to 20th, remains of No. 29; north-east, 7th until 10th, the remains of No. 29; also faculae on 11th and 28th; south-west on 3rd (278°, S. 38°, and 265°, S. 20°), 18th, and 19th; south-east 1st (175°, S. 20°), 7th, and 8th (84°, S. 29°), the remains of No. 28; 9th and 10th, the remains of No. 30; 11th and 12th (19°, S. 19°); also near the limb some 20° distant from the North Pole, towards the west on October 1st.

Our chart is constructed from the combined observations of Messrs. John McHarg, E. E. Peacock, and F. C. Dennett.

DAY OF OCTOBER, 1914.



# THE FACE OF THE SKY FOR JANUARY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

TABLE 54.

| Date. | Sun. R.A. | Sun. Dec. | Moon. R.A. | Moon. Dec. | Mercury. R.A. | Mercury. Dec. | Venus. R.A. | Venus. Dec. | Vesta. R.A. | Vesta. Dec. | Jupiter. R.A. | Jupiter. Dec. | Saturn. R.A. | Saturn. Dec. | Neptune. R.A. | Neptune. Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Greenwich Noon. | h. m. | ° | h. m. | ° | h. m. | ° | h. m. | ° | h. m. | ° | h. m. | ° | h. m. | ° | h. m | ° |
| Jan. 1 | 18 43·5 | S.23·1 | 6 44·1 | N.26·9 | 18 33·3 | S.24·8 | 15 57·9 | S.16·1 | 4 34·2 | N.17·7 | 21 40·5 | S.14·9 | 5 51·1 | N.22·3 | 8 6·6 | N.19·9 |
| ,, 6 | 19 5·6 | 22·6 | 11 1·5 | N. 4·6 | 19 8·7 | 24·4 | 16 9·4 | 16·5 | 4 30·8 | 17·9 | 21 44·6 | 14·5 | 5 49·4 | 22·3 | 8 6·1 | 19·9 |
| ,, 11 | 19 27·4 | 21·9 | 15 24·7 | S. 24·0 | 19 44·4 | 23·4 | 16 23·1 | 17·0 | 4 28·1 | 18·1 | 21 48·9 | 14·2 | 5 47·8 | 22·3 | 8 5·5 | 19·9 |
| ,, 16 | 19 49·0 | 21·1 | 20 38·7 | S. 20·3 | 20 20·0 | 21·7 | 16 38·7 | 17·6 | 4 26·1 | 18·3 | 21 53·2 | 13·8 | 5 46·3 | 22·3 | 8 4·9 | 20·0 |
| ,, 21 | 20 10·3 | 20·1 | 0 36·0 | N. 7·9 | 20 55·0 | 19·4 | 16 55·9 | 18·3 | 4 25·0 | 18·5 | 21 57·5 | 13·4 | 5 44·9 | 22·3 | 8 4·4 | 20·0 |
| ,, 26 | 20 31·3 | 18·9 | 4 35·0 | N.27·1 | 21 28·5 | 16·5 | 17 14·5 | 18·9 | 4 24·6 | 18·8 | 22 2·0 | 13·0 | 5 43·7 | 22·3 | 8 3·8 | 20·0 |
| ,, 31 | 20 52·0 | S.17·6 | 9 8·3 | N.17·6 | 21 58·7 | S.13·1 | 17 34·2 | S.19·4 | 4 25·0 | N.19·1 | 22 6·5 | S.12·6 | 5 42·6 | N.22·4 | 8 3·2 | N.20·1 |

TABLE 55.

| Date. | Greenwich Noon. Sun. P | Sun. B | Sun. L | Greenwich Midnight. Moon. P | Jupiter. P | B | $L_1$ | $L_2$ | $T_1$ | $T_2$ |
|---|---|---|---|---|---|---|---|---|---|---|
| | ° | ° | ° | ° | ° | ° | ° | ° | h. m. | h. m. |
| Jan. 1 | + 2·2 | −3·1 | 91·1 | + 5·9 | Jan. 1 | −21·2 | +0·4 | 288·2 | 261·9 | 4 7 *e* | 4 47 *e* |
| ,, 6 | − 0·2 | 3·7 | 25·2 | +21·8 | ,, 8 | 21·5 | 0·4 | 311·7 | 232·0 | 3 29 *e* | 5 36 *e* |
| ,, 11 | 2·6 | 4·2 | 319·4 | +12·0 | ,, 15 | 21·9 | 0·5 | 335·2 | 202·0 | 2 50 *e* | 6 26 *e* |
| ,, 16 | 5·0 | 4·7 | 253·5 | −15·3 | ,, 22 | 22·2 | 0·5 | 358·6 | 172·1 | 2 12 *e* | 7 15 *e* |
| ,, 21 | 7·3 | 5·2 | 187·7 | −21·7 | ,, 29 | −22·6 | +0·6 | 22·1 | 142·1 | 1 33 *e* | 8 5 *e* |
| ,, 26 | 9·5 | 5·6 | 121·9 | − 6·3 | | | | | | | |
| ,, 31 | − 11·7 | −6·0 | 56·0 | +17·1 | | | | | | | |

P is the position angle of the North end of the body's axis measured eastward from the North Point of the disc. B, L are the helio-(planeto-)graphical latitude and longitude of the centre of the disc. In the case of Jupiter, System I refers to the rapidly rotating equatorial zone, System II to the temperate zones, which rotate more slowly. To find intermediate passages of the zero meridian of either system across the centre of the disc, apply to $T_1$, $T_2$ multiples of $9^h\ 50^m{\cdot}7$, $9^h\ 55^m{\cdot}8$ respectively.

For the future the data for the Moon and Planets in the Second Table will be given for Greenwich Midnight, *i.e.*, the Midnight at the end of the given day.

The letters *m*, *e*, stand for morning, evening. The day is taken as beginning at midnight.

THE SUN has commenced to move Northwards; nearest Earth $2^d\ 6^h\ e$. Its semi-diameter diminishes from 16′ 18″ to 16′ 16″. Sunrise changes from $8^h\ 8^m$ to $7^h\ 43^m$; sunset from $3^h\ 58^m$ to $4^h\ 45^m$.

MERCURY is an evening star from the 6th. Semi-diameter increases from 2½″ to 3″. Illumination diminishes from Full to ¾.

VENUS is a morning star, at Greatest Brilliance on 2nd. Illumination increases from ½ to ½. Semi-diameter diminishes from 21″ to 13″.

THE MOON. — Full $1^d\ 0^h\ 20^m\ e$. Last quarter $8^d\ 9^h\ 13^m\ e$. New $15^d\ 2^h\ 42^m\ e$. First quarter $23^d\ 5^h\ 32^m\ m$. Full $31^d\ 4^h\ 41^m\ m$. Perigee $12^d\ 2^h\ e$. Apogee $24^d\ 9^h\ m$, semi-diameter 16′ 21″, 14′ 48″ respectively. Maximum librations $5^d$ 5° E., $11^d$ 7° N., $18^d$ 6° W., $25^d$ 7° S., $31^d$ 5° E. The letters indicate the region of the Moon's limb brought into view by libration. E., W. are with reference to our sky, not as they would appear to an observer on the Moon (see Table 56).

MARS is invisible; in conjunction with Sun Dec. 24th.

VESTA is in Taurus, 1½° North of Aldebaran on 5th. It is of the 7th magnitude, and visible with a binocular.

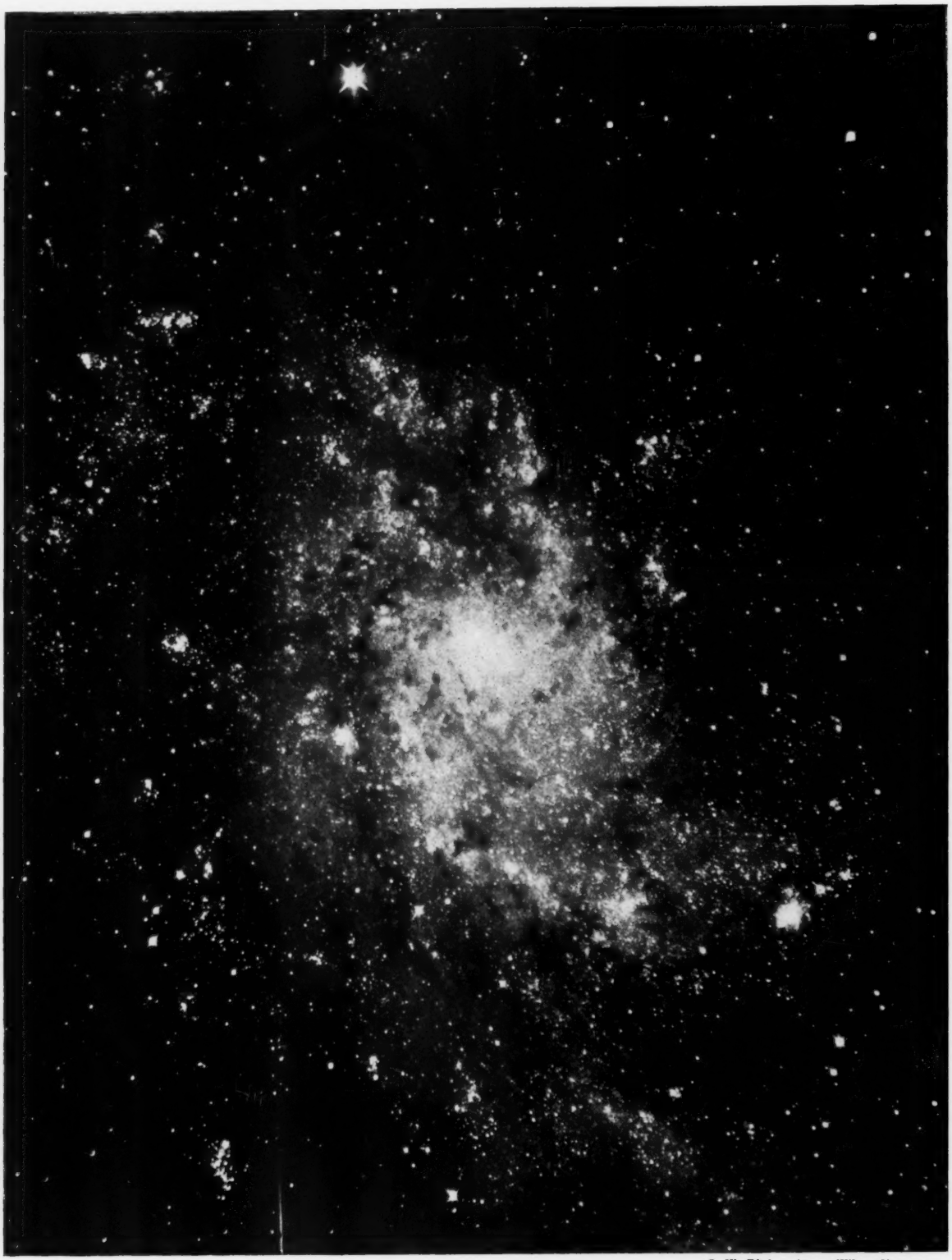
JUPITER is an evening star, in Capricornus, 2° North of δ Capricorni on 3rd. Polar semi-diameter 16″.

Configuration of satellites at $6^h\ e$ for an inverting telescope.

JUPITER'S SATELLITES.

| Day. | West. | East. | Day. | West. | East. |
|---|---|---|---|---|---|
| Jan. 1 | 1 ○ | ¾4 | Jan. 13 | 42 ○ | 13 |
| ,, 2 | 23 ○ | 14 | ,, 14 | 421 ○ | 3 |
| ,, 3 | 321 ○ | 4 | ,, 15 | 4 ⊙ | 23 |
| ,, 4 | 3 ○ | 124 | ,, 16 | 42 ⊙ | 1 |
| ,, 5 | 13 ○ | 24 | ,, 17 | 321 ○ | 4 |
| ,, 6 | 2 ○ | 134 | ,, 18 | 3 ○ | 214 |
| ,, 7 | ○ | 43 1●2● | ,, 19 | 31 ○ | 24 |
| ,, 8 | 1 ○ | 423 | ,, 20 | 2 ○ | 134 |
| ,, 9 | 423 ○ | 1 | ,, 21 | 21 ○ | 34 |
| ,, 10 | 4321 ○ | | ,, 22 | ○ | 1234 |
| ,, 11 | 43 ○ | 12 | ,, 23 | ⊙ | 134 |
| ,, 12 | 4¾ ○ | 2 | ,, 24 | 321 ○ | 4 |

The following satellite phenomena are visible at Greenwich, all in the evening:—$7^d\ 4^h\ 48^m$ I. Oc. D., $4^h\ 56^m$



*From a photograph by* *G. W. Ritchey, Mount Wilson Observatory.*

The Spiral Nebula, August 5–7, 1910.

M. 33 Trianguli N.G.C. 598. Position of Nebula R.A. $1^h\ 28^m$. Decl. $+\ 30^\circ\ 9'$ Reflector.
Ap. 60-ins. (1·524m.) F.L. 299-ins. (7·6m.) Exp. $8^h\ 30^m$.

II. Oc. D.; $8^d\ 4^h\ 25^m$ I. Tr. E., $5^h\ 12^m$ I. Sh. E.; $9^d\ 7^h\ 15^m$ III. Sh. E.; $14^d\ 6^h\ 50^m$ I. Oc. D.; $15^d\ 4^h\ 48^m$ I. Sh. I., $6^h\ 27^m$ I. Tr. E.; $16^d\ 4^h\ 18^m\ 2^s$ I. Ec. R., $4^h\ 56^m$ III. Tr. I., $5^h\ 20^m$ II. Tr. E., $6^h\ 40^m$ II. Sh. E.; $17^d\ 6^h\ 51^m\ 23^s$ IV. Ec. R.; $22^d\ 6^h\ 9^m$ I. Tr. I., $6^h\ 43^m$ I. Sh. I.; $23^d\ 5^h\ 13^m$ II. Tr. I., $6^h\ 12^m\ 50^s$ I. Ec. R., $6^h\ 19^m$ II. Sh. I.

Eclipses will take place to the right of the disc in an inverting telescope, taking the direction of the belts as horizontal.

SATURN was in opposition December 21st, in Gemini. Polar semi-diameter $9\frac{1}{2}''$. Major axis of ring $46''$, minor $20\frac{1}{2}''$. Angle P—5°·8.

Eastern elongations of Tethys (every 4th given) $1^d\ 10^h\cdot1\ e$, $9^d\ 11^h\cdot3\ m$, $17^d\ 0^h\cdot4\ m$, $24^d\ 1^h\cdot6\ e$; of Dione (every 3rd given) $1^d\ 6^h\cdot1\ e$, $9^d\ 11^h\cdot0\ e$, $18^d\ 4^h\cdot0\ m$, $26^d\ 8^h\cdot9\ m$; of Rhea (every 2nd given) $3^d\ 5^h\cdot9\ m$, $12^d\ 6^h\cdot5\ m$, $21^d\ 7^h\cdot1\ m$, $30^d\ 7^h\cdot8\ m$.

TABLE 56. Occultations of Stars by the Moon visible at Greenwich.

| Date. | Star's Name. | Magnitude. | Disappearance. | | Reäppearance. | |
|---|---|---|---|---|---|---|
| | | | Time. | Angle from N. to E. | Time. | Angle from N. to E. |
| 1915. | | | h. m. | ° | h. m. | ° |
| Jan. 1 | WZC 489 | 7·0 | — | — | 8 5 *e* | 323 |
| ,, 2 | A Geminorum | 5·1 | 3 17 *m* | 43 | 3 42 *m* | 359 |
| ,, 2 | $\mu^1$ Cancri | 6·2 | 8 22 *e* | 55 | 9 9 *e* | 329 |
| ,, 2 | WZC 554 | 7·2 | — | — | 9 33 *e* | 287 |
| ,, 3 | WZC 616 | 6·6 | — | — | 9 37 *e* | 277 |
| ,, 4 | WZC 620 | 7·9 | — | — | 1 36 *m* | 266 |
| ,, 6 | 37 Sextantis | 6·3 | 0 47 *m* | 76 | 1 35 *m* | 352 |
| ,, 7 | $\upsilon$ Leonis | 4·5 | 2 49 *m* | 158 | 3 51 *m* | 277 |
| ,, 9 | BD — 12°·3785 | 7·0 | — | — | 3 15 *m* | 325 |
| ,, 9 | WZC 849 | 7·0 | — | — | 6 45 *m* | 245 |
| ,, 18 | BD — 8°·5912 | 6·4 | 7 12 *e* | 27 | — | — |
| ,, 23 | 26 Arietis | 6·1 | 11 25 *e* | 41 | 0 16* *m* | 290 |
| ,, 24 | WZC 189 | 6·9 | 7 57 *e* | 92 | — | — |
| ,, 27 | BD + 27°·880 | 7·0 | 4 55 *e* | 68 | — | — |
| ,, 27 | 136 Tauri | 4·5 | 6 48 *e* | 74 | 8 5 *e* | 281 |
| ,, 27 | BD + 27°·943 | 7·0 | 11 8 *e* | 150 | — | — |
| ,, 27 | BAC 1918 | 6·1 | 11 22 *e* | 69 | 0 26* *m* | 311 |
| ,, 29 | 39 Geminorum | 6·1 | 0 11 *m* | 84 | 1 17 *m* | 311 |
| ,, 29 | 40 Geminorum | 6·3 | 0 35 *m* | 109 | 1 46 *m* | 286 |
| ,, 29 | BAC 2514 | 6·0 | 4 16 *e* | 43 | 4 50 *e* | 330 |
| ,, 30 | WZC 550 | 6·8 | 5 23 *m* | 139 | — | — |
| ,, 30 | $\mu^2$ Cancri | 5·4 | 7 19 *m* | 178 | — | — |
| ,, 30 | $\eta$ Cancri | 5·5 | 4 1 *e* | 74 | 4 48 *e* | 311 |
| ,, 30 | WZC 587 | 6·7 | 7 13 *e* | 129 | — | — |
| ,, 30 | 39 Cancri | 6·5 | 7 17 *e* | 78 | 8 16 *e* | 317 |
| ,, 30 | 40 Cancri | 6·5 | 7 19 *e* | 85 | 8 22 *e* | 310 |
| ,, 30 | BAC 2919 | 6·4 | 7 42 *e* | 149 | 8 33 *e* | 246 |
| ,, 30 | WZC 594 | 6·7 | 7 43 *e* | 130 | — | — |
| ,, 30 | WZC 595 | 6·7 | 8 9 *e* | 165 | — | — |
| ,, 30 | WZC 597 | 7·0 | 8 12 *e* | 74 | — | — |
| ,, 31 | BAC 2991 | 6·1 | 1 42 *m* | 95 | 2 44 *m* | 324 |
| ,, 31 | 7 Leonis | 6·2 | 9 29 *e* | 139 | 10 35 *e* | 275 |
| ,, 31 | 11 Leonis | 6·6 | 10 33 *e* | 93 | 11 39 *e* | 327 |

From New to Full disappearances take place at the Dark Limb, from Full to New reäppearances.

The asterisk indicates the day following that given in the date column.

Attention is called to the unusual number of occultations in the last week of January.

TABLE 57. LONG-PERIOD VARIABLE STARS.

| Star. | Right Ascension. | Declination. | Magnitudes. | Period. | Date of Maximum. |
|---|---|---|---|---|---|
| | h. m. s. | ° ′ | | d. | |
| T Cassiopeiae | 0 18 37 | +55 19 | 6·7 to 12·5 | 443 | 1914—Dec. 24 |
| R Piscium | 1 26 15 | + 2 26 | 7·0 to 14·0 | 344 | ,, Dec. 12 |
| U Persei | 1 53 57 | +54 24 | 7·0 to 10·9 | 317 | 1915—Feb. 14 |
| W Andromedae | 2 12 11 | +43 55 | 6·5 to 13·8 | 395 | ,, Feb. 9 |
| Mira Ceti | 2 15 3 | − 3 21 | 2·0 to 9·6 | 331 | ,, Feb. 11 |
| R Leonis Min. | 9 40 29 | +34 54 | 6·2 to 1·3 | 371 | ,, Jan. 14 |

Special attention should be given to Mira Ceti, which will be approaching Maximum in January. It must be observed as early in the evening as possible.

Night Minima of Algol $9^d\ 4^h\cdot5\ m$, $12^d\ 1^h\cdot3\ m$, $14^d\ 10^h\cdot1\ e$, $17^d\ 6^h\cdot9\ e$, $29^d\ 6^h\cdot2\ m$. Period $2^d\ 20^h\ 48^m\cdot9$.

Principal Minima of $\beta$ Lyrae January $9^d\ 2^h\ m$, $22^d\ 0^h\ m$. Period $12^d\ 21^h\ 47^m\cdot5$.



XUM

For Titan and Japetus E., W. stand for East and West elongations, I. for Inferior (North) conjunction, S. for Superior (South) conjunction. Titan $3^d\ 5^h\cdot0\ e$ E., $7^d\ 4^h\cdot1\ e$ I., $11^d\ 1^h\cdot2\ e$ W., $15^d\ 0^h\cdot5\ e$ S., $19^d\ 2^h\cdot4\ e$ E., $23^d\ 1^h\cdot8\ e$ I., $27^d\ 10^h\cdot7\ m$ W., $31^d\ 10^h\cdot0\ m$ S.; Japetus $20^d\ 5^h\cdot0\ e$ E.

URANUS is invisible. In conjunction with Sun February 1st.

NEPTUNE is in opposition on 20th, diameter 2″. 2¼° S. of Moon at midnight on 2nd.

DOUBLE STARS AND CLUSTERS.—The tables of these given three years ago are again available, and readers are referred to the corresponding month of three years ago.

VARIABLE STARS.—Stars reaching their maxima in or near January 1915 are included. The lists in recent months may also be consulted.

METEOR SHOWERS (from Mr. Denning's List):—

| Date. | Radiant. R.A. | Radiant. Dec. | Remarks. |
|---|---|---|---|
| Jan. 2-3 ... | 230° | + 53° | Brilliant, swift; long paths. |
| ,, 3 .. | 156 | + 41 | Swift. |
| ,, 11-25 ... | 220 | + 13 | Swift, streaks. |
| ,, 17 ... | 295 | + 53 | Slow, bright. |
| ,, 17-23 ... | 159 | + 27 | Swift. |
| ,, 25 ... | 131 | + 32 | Swift. |
| ,, 29 ... | 213 | + 52 | Very swift. |

# NOTES.

## ASTRONOMY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

STATISTICS OF STELLAR PARALLAXES.—Mr. O. R. Walkey has kindly sent me a reprint of his paper in *Astr. Nachr.*, No. 4754. He has classified all reliable measures of parallax. He admits that the resulting statistics are apt to be misleading as regards the stellar system as a whole; for, while all the bright stars have been measured for parallax, only those faint ones that have considerable proper motion have been measured. The results support those that have been deduced by other methods. Thus the absolute luminosity is greatest for stars of the B type, and diminishes in succession for Types A, G, K, M. There is, perhaps, some evidence for the separation of the M stars into giants and dwarfs, as first suggested by Professor H. N. Russell. Three hundred and seventeen of the stars discussed are brighter than the Sun, and two hundred and twenty-seven fainter. He puts fifteen stars within thirteen light-years (parallax ¼″), and considers that the list down to this point is complete, but that more stars are still to be added to the forty-three lying within twenty light-years.

He has not included radial velocities in his statistics, but the cross velocities are tabulated, and support the conclusion, now generally accepted, that the speed increases with advancing age. He gives twelve miles per second for the Type A stars, twenty-five miles for Types F and K, thirty miles for the solar type G, so that our Sun's velocity is far below the average velocity of its class.

Direct parallax measures do not take us very far into the stellar system. We can make a much deeper plunge into space by using the results of proper motion combined with measures of radial velocity where these are available.

THE NINTH SATELLITE OF JUPITER.—The discovery of this very tiny body, which is of the 19th magnitude, was briefly announced by telegram last July. Some further particulars, confirming its satellite character, are contained in the October number of the *Publications of the Astronomical Society of the Pacific*. The object was first photographed on July 21st last by Mr. Seth B. Nicholson, using the Crossley reflector, and giving a two hours' exposure: it was found 15′ east, 6′ south of the eighth satellite, and one magnitude fainter. It was photographed daily till the end of July, and on August 21st, 22nd, 23rd. The orbit was deduced by Leuschner's method, and proved to be an ellipse with a period of nearly three years, so that it is still further from Jupiter than the eighth, whose period is two years. The solar perturbations must be extraordinarily large, and the stability of the orbit uncertain. Like VIII, its motion is retrograde: this was to be expected, for Mr. Jackson recently showed that such motion was stable at a greater distance from the primary than direct motion. The eccentricity and inclination of the orbit of IX are not yet given, but are probably large. It goes four times round Jupiter, while Jupiter goes once round the Sun. The number of synodic months in a Jovian year is, however, five, owing to the retrograde motion. Jupiter now equals Saturn in the number of known companions, as the existence of Saturn X (Themis) has not been fully confirmed. The same publication contains other interesting matter. Dr. W. W. Coblentz writes on the heat of the stars, as measured with a thermopile attached to the Crossley reflector. As might be expected, the stars of late type show much more heat in proportion to their luminosity than the early types. Thus Arcturus is found to radiate 2·42 times the energy that Vega does. The two stars of Class M, Beta Pegasi and Alpha Herculis, have extremely high heating power. A test of the distribution of energy in different parts of the spectrum was afforded by interposing a layer of water, one centimetre thick, which absorbed the long infra-red rays. Sixty per cent. of the energy was transmitted for Sirian stars, forty per cent. for solar ones, twenty-five per cent. for red ones. The planets were also tested. From fifty to sixty per cent. of the light of Venus, Saturn, and Jupiter was transmitted through the water cell, but only fourteen per cent. of the Moon's rays. It was concluded that owing to the absence of an atmosphere, and the low albedo, the Moon's surface gets hotter than those of the planets, and a larger fraction of its energy consists of infra-red rays.

Professor W. S. Adams gives an interesting case of a Sirian star of very low absolute luminosity. This is the ninth-magnitude companion of Omicron Eridani; taking the parallax as 0″·17, the absolute magnitude is 4·8 magnitudes below the Sun.

A communication from Mount Wilson states that RS Boötis has a photographic magnitude range fifty per cent. greater than the visual range; in other words, it gets redder at minimum, which is confirmed by the spectrum at maximum being of Type B8 (Helium), while at minimum it is of Type Fo (Procyon). From Mount Wilson also comes a note on the spectra of stars in the Great Hercules cluster, Messier thirteen. Out of twenty stars examined, one is of Type Ao, six of Type A5, nine of Type Fo, three of Type F 5, one of Type Go: these figures are similar to those of nineteen other stars in the cluster previously published.

Professor Aitken has a note on Epsilon Hydrae. Periastron will be passed in April, 1916. The angular motion is very rapid at this time, 180° being traversed in a year. Spectroscopic determinations of the motion of the principal star in the line of sight will increase our knowledge of the orbit and of the masses and distance of the system. It is to be hoped that advantage will be taken of this opportunity.

ROTATION PERIODS OF SATURN'S SATELLITES.—Some months ago Professor Lowell announced the variability of Tethys and Dione to the extent of a quarter magnitude, the period in each case being the same as that of the revo-

XUM

lution. In *Lowell's Bulletin* 64 he announces a similar conclusion in regard to Mimas and Enceladus. Their magnitudes and ranges are given as: Mimas 12·90 to 13·33; Enceladus 12·33 to 12·67. Both are brightest near the western elongations, agreeing in this respect with Japetus, whose range of variation is greater. It is concluded that all the satellites resemble our Moon in always turning the same face to their primary. This would be a natural consequence of the powerful tidal action of the primary.

## CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (OXON), F.I.C.

AMERICA AND THE DYESTUFF INDUSTRY.—The stoppage of the supply of aniline dyestuffs from Germany appears to have been felt even more severely in the United States than in this country. Unless the dyes can be imported or rapidly manufactured, the closing of numerous American textile factories will soon be inevitable. Hitherto attempts to obtain fresh supplies from Germany have been fruitless, and the *Metallurgical and Chemical Engineer* (1914, p. 551) has therefore been inquiring of a few prominent American chemists as to the practical feasibility of manufacturing the products at home.

In reply, Dr. Nicholson stated that everything would depend upon the encouragement given by the buyer to the manufacturer, while Mr. Matheson pointed out that the industry was already well advanced, as far as regarded intermediate products, such as aniline oil and aniline salts, and that its further advance was contingent upon a supply of cheap benzene.

Dr. Hesse remarked that the United States already produced about a third of its requirements of aniline dyes, but that they were manufactured almost exclusively from intermediate compounds imported from Germany. In the case of these products (including aniline oil, aniline salts, naphthylamine, anthraquinone, and other compounds), Germany controlled the markets of the world, owing to the fact that her factories were interdependent, each of the large number of products being made by interaction with other products, none of which was of use by itself. Hence it would not be sufficient to transplant one of the twenty-two German factories to America, but it would also be necessary to take some part of each of them in order to have a complete and self-contained industry. About seven hundred different dyes were manufactured in Germany, and this would involve the simultaneous use of some three hundred and fifty sets of apparatus, demanding skilled work in every stage. Even if the industry could be transplanted bodily, the profits would not correspond to the expense, effort, and risk involved, seeing that eventually it would hardly be possible to maintain the ground against the competition of an old-established industry of this nature.

In the opinion of Dr. Matos the problem was not one of the lack of skilled chemists, but of the temporary handicap of not having the specially constructed apparatus for the technical processes involved in converting the intermediate compounds into the final products. The primary question was whether sufficient coal-tar was produced in America, and whether higher prices could be obtained for certain products of the distillation of coal-tar than the colour industry could afford to give.

## GEOGRAPHY.

By A. SCOTT, M.A., B.Sc.

DESERTS.—At the Australian meeting of the British Association a number of papers was read in Section C on Deserts and Desert Formations (*Geol. Mag.*, September, 1914). Professor Gregory defined a desert as a country unoccupied on account of arid climate. Deserts arise through a combination of causes, the chief being climate, the geological structure—surface rocks permeable and crumbling to coarse-grained deposits—and geographical conditions, *e.g.*, plateau land with an escape for water by drainage to surrounding lowlands. With regard to climate, it is not only the amount of rain which is important, but also its distribution throughout the year, as well as the rate of evaporation. Desert soils often contain an excess of potash and lime, owing to the small amount of leaching. The Australian soils, however, are remarkable for their low phosphate content, the average amounts varying from ·047 to ·06 per cent., while English soils average ·098 and American ·116. Elsewhere the subsoil has generally less phosphate than the soil, but this is not the case in Australia. This low phosphate content has been explained as due to the comparative scarcity of mammalian life, which is the source of the phosphate.

Dr. W. F. Hume discussed the physiography of arid lands, with special reference to Egypt. The five chief features of the latter country, the oases, the Libyan desert, the Nile valley, the Wilderness of Sinai, and the coastal plains were explained in terms of their geological history, and the conclusion reached that "the surface structure of an arid land is not only a direct reflex of its geological structure, but also of former climatic change." There is abundant evidence of a former pluvial period in Egypt, but such a period, as pointed out recently by Professor Gregory (*Geog. Journ.*, February–March, 1914), is long prehistoric.

The features which are typical of most desert regions, whatever their origin and history, were summarised, and they include; evidence of wind erosion and the formation of plateaux, with intense scouring of the surface by sand-grains; the formation of dunes in sheltered places and of pillars of harder materials, often undercut at their bases; the wearing of pebbles into the form of dreikante; the breaking up of rocks by the great temperature variation and the fracturing and flaking off of surface zones; the formation of deposits of various oxides leached out of rocks and precipitated, by evaporation, at the surface.

Half deserts, with their brief but intense rain, are characterised by deep cañon valleys, saw-back ridges, salt marshes, great amounts of talus, and so on.

Mr. H. F. Ferrar described the dust dunes of Northern Egypt as deposits of loess, and showed that a desert formation, interstratified between two alluvial deposits, did not necessarily postulate any climatic change. Professor Walther dealt with the action of wind and water as agents of denudation in arid regions.

## GEOLOGY.

By G. W. TYRRELL, A.R.C.Sc., F.G.S.

ARCHAEAN GEOLOGY IN CANADA.—In 1887 a memoir, now become classical, on the Geology of the Rainy Lake Region of Canada, was published by Dr. A. C. Lawson. This memoir caused a fundamental revolution in the ideas of geologists concerning the relations of the various Archaean rocks of Canada, and indeed of the whole world. Before the publication of the Rainy Lake memoir the great masses of granitoid gneiss, known variously as the Ottawa Gneiss, the Fundamental Gneiss, or the Laurentian Gneiss, were believed to consist of metamorphosed sediment, and to be the basement upon which all other rocks rested. Dr. Lawson's great achievement was to show that this so-called Fundamental Gneiss is really a plutonic igneous rock, intrusive in, and later than, the metamorphic rocks with which it is associated. Dr. Lawson described two series of metamorphic rocks into which the gneiss was intruded: the Keewatin, consisting mainly of volcanic rocks; and, below this, the Coutchiching, a series of metamorphic sedimentary strata free from volcanic admixture. This interpretation of Canadian Archaean geology has been favourably received by geologists, with the exception of the Coutchiching Series, the stratigraphical position of which was regarded as doubtful. In view of the economic importance of the Archaean rocks of Canada, it was felt that this point ought to be settled; and, accordingly, the Geological Survey of Canada asked Dr. Lawson to resurvey the Rainy Lake area in the light of the new observations of the last twenty-five

XUM

years, and under the more favourable conditions of study and travel now available. The result of this work is a most interesting and important new publication by Dr. Lawson entitled "The Archaean Geology of Rainy Lake Restudied" (Memoir No. 40, Geological Survey of Canada, 1913). The results of the new survey may be briefly summarised as follows. The stratigraphical position of the Coutchiching Series, determined in 1887 as underlying the Keewatin, is fully confirmed. Furthermore, the gneisses formerly grouped under the inclusive term "Laurentian" have been found to belong to two widely separated periods of time within the Archaean. This result has also become apparent in recent years to workers on the Archaean in other areas. For the older of these periods the name "Laurentian" is retained, and for the later period it is proposed to use the term "Algoman," from the old district of Algoma. Two other series of rocks were discovered: one, known as the Steeprock Series, consists of sediments and volcanics, including several hundred feet of fossiliferous limestone, and containing the oldest fossils at present known; the other new series is the Seine, comprising conglomerates, quartzites, and slates. These two series are tentatively correlated with the Lower and the Upper Huronian of Lake Huron. After the deposition of the Seine Series the region was again invaded by great intrusions of granite and syenite gneiss, for which the term "Algoman" has been proposed, to distinguish them from the Laurentian gneisses of much older date.

## METEOROLOGY.

By WILLIAM MARRIOTT, F.R.MET.SOC.

**AUSTRALIAN WEATHER FORECASTS**—The average percentage of the official weather forecasts issued by the Commonwealth Meteorologist, which have been verified from the inception of the Meteorological Bureau on January 1st, 1908, to December 31st, 1912, is as follows:—

| | | | |
|---|---|---|---|
| Western Australia ... | 87·6 | Victoria..... | 88·1 |
| Southern Australia ... | 86·3 | Tasmania ..... | 84·5 |
| Queensland ..... | 88·7 | Ocean Forecasts ..... | 83·8 |
| New South Wales ... | 88·1 | | |

The percentage of verification for the whole Commonwealth has thus been 86·7. If the low amount obtained in 1908, which may be attributed to the initiatory and unsettled state of the Service, had not been taken into account the percentage would have been 88·0.

The success of the forecasts during the last four years is no doubt due to the system under which the forecasts are made. The Australian differs from others in that, while the responsibility of issuing forecasts is deputed to an individual in other lands, these are formulated on a consensus of opinion of officers experienced in forecasting from all of the States. These officers each have charge of a branch of work in the Central Bureau, but at noon each day they meet and discuss with the Commonwealth Meteorologist the various charts that have been prepared up to that hour from meteorological observations received from all parts of Australia. After studying the data each officer simultaneously writes out his forecast for, say, Western Australia. The Commonwealth Meteorologist then reads his written opinion, maintains, adds to, or modifies his forecast, according to the views of the officer from that State. The urgency of getting the forecasts as early as possible precludes lengthened discussion, for forecasts for all the States must be despatched from the Central Bureau between 12.15 and 12.30 p.m.; but any points at variance are fully investigated after despatch, old examples, types, and records are fully compared, and, if necessary, any particular forecast may be intercepted and altered; but so well does the system work that it is very seldom indeed found necessary to change the wording of any forecast when once it has left the Office.

## MICROSCOPY.

By F.R.M.S.

III.—THE COMMON EARWIG (*FORFICULA AURICULARIA*) (***continued from page*** 402).—An interesting addition to the remarks which have been made upon the structure of the Common Earwig is given in the present number (see Figure 417). It consists of photographs of all the British Earwigs, and they have been taken and kindly lent for reproduction by Mr. W. J. Lucas—well known for his work on British Dragon Flies—who has also paid considerable attention to other insects, including those in question. The males of each species are shown, and they are magnified about two and a half times. *Labidura riparia*, as compared with our common species of Earwig, is a veritable giant. It is found on the South Coast, and is not very familiar to those who are not specially interested in Earwigs.

IV.—THE DRAGON-FLY (*AGRION PUELLA*).—The eggs are deposited in the tissue of water weeds. Their length is about 1·3 millimetres and the greatest breadth is 3·5 millimetres. They are quite colourless and semi-transparent, and form a cylindrical sac, with one end pointed and the other rounded. Under favourable conditions of temperature they hatch in about four weeks. From the egg comes the pronymph, as it is called, which very soon changes its skin, giving rise to the nymph. The casting of the embryonic wrapping is not a moult in the strict sense of the term, and it would be more correct to assume that the process of hatching takes place in two stages. The nymphs swim very freely.

The species *Agrion puella* (see Figure 418) is a small one, and suitable for microscopical work. As the nymphs are carnivorous, it is advisable to keep them separate. In their early stages Infusoria and Water-fleas, and later on freshwater Shrimps and Tadpoles, form a suitable diet. Various species of Dragon-flies can be recognised in the nymph stage, and in the one which we are considering there are three pointed semi-transparent flakes projecting from the hinder end of the body, which act as tracheal gills. The creature can capture only slow animals by pursuit, but, escaping notice owing to its dark colour and motionless attitude, it is able to seize its prey by an arm-like appendage of the head. This (see Figure 419) is a modification of the second pair of maxillae, which in other insects, we saw, formed the labium. In the Dragon-fly nymph this is carried on a jointed arm with a pair of claws at the tip.

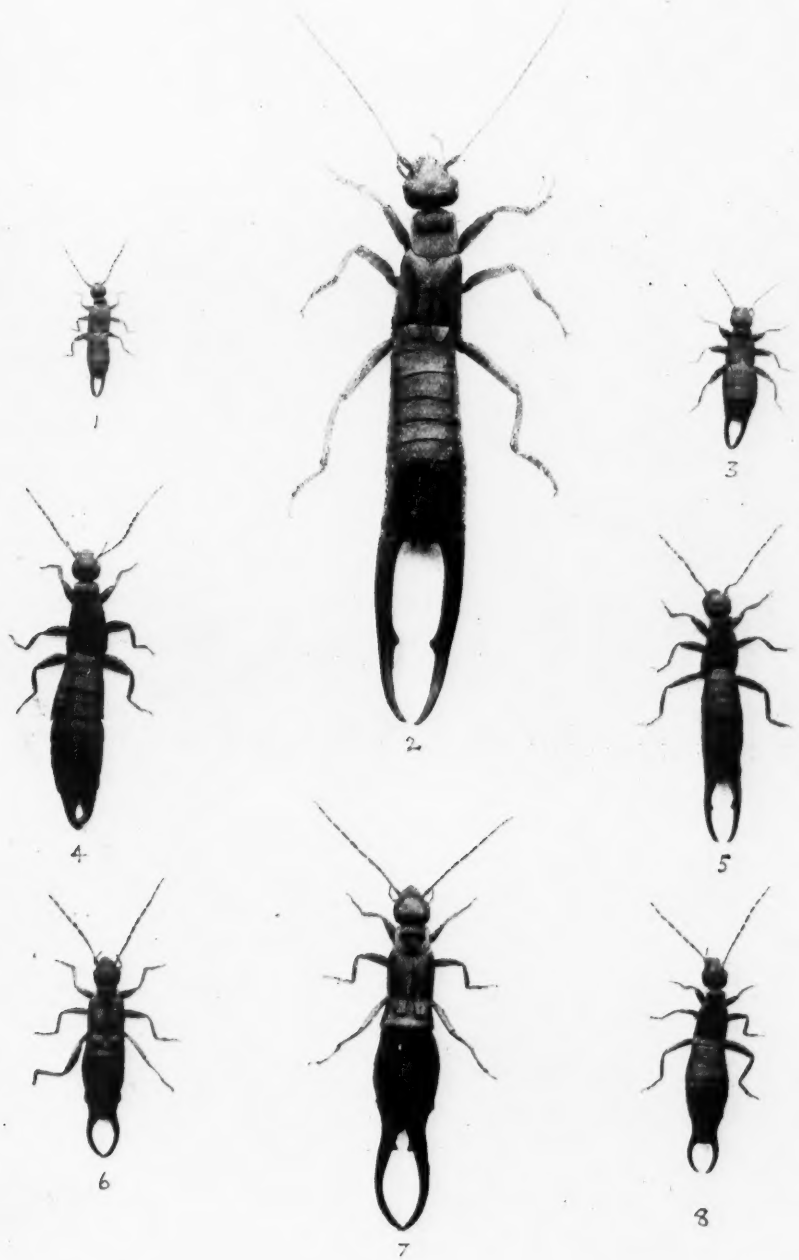
The respiration of the nymph varies slightly according to the family. In Libellulidae a pair of large spiracles are located on the dorsal region behind the head, between the narrow prothorax and mesothorax. In *Agrion puella* these spiracles are hidden, unfortunately, but can in isolated cases be observed only by careful examination, whereas by dissection another pair can be made out (see Figure 420).

For some time entomologists were under the impression that these spiracles were closed during the aquatic period, and various experiments showed that the nymph when under water breathes through its tail, and when out of water through its spiracles, that is to say, its true aërial breathing organs.

In his valuable notes, Dewitz showed that this was not true, and that respiration can be carried out in several ways. By employing various experiments he showed that the rectal respiratory movements were more effective than tracheal movements,* but in young nymphs the thoracic spiracles are not pervious, whereas in older nymphs they were ready for transformation, and acted in the ordinary way.

To prove this he closed the rectum of young nymphs with collodion, and by carrying out the same methods in older nymphs ready for transformation he found that when either the rectum or spiracles were closed the nymph lived, but on closing both the nymph died.

* *Zoolog. Ans.*, Bd. XIII, 1891, pages 500-4, 525-31.




*From photographs by* *W. J. Lucas, B.A., F.E.S.*

FIGURE 417. British Earwigs ♂. × about $2\frac{1}{2}$.

1. *Labia minor.*
2. *Labidura riparia.*
3. *Prolabia arachidis.*
4. *Anisolabis annulipes.*
5. *Apterygida albipennis.*
6. *Forficula auricularia.*
7. *Forficula auricularia* var. *forcipata.*
8. *Forficula lesnei.*

XUM

FIGURE 418. Nymph of Dragon-fly (*Agrion puella*) in latter stages of developments. × about 12.

FIGURE 419. Appendage of Head of Dragon-fly (*Aeschnis grandis*). × about 11.

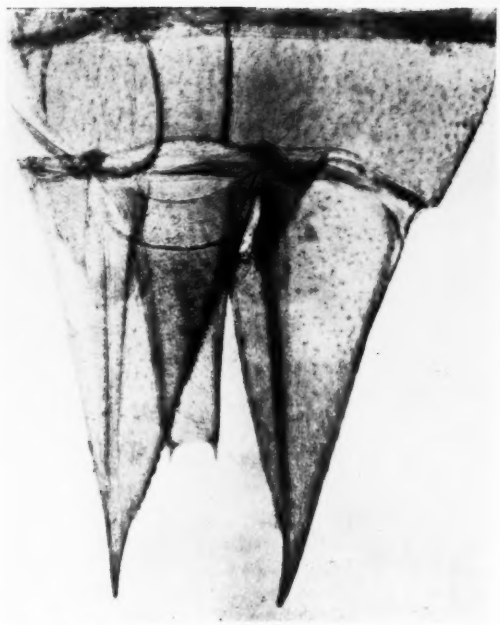


FIGURE 420. The thoracic spiracles of nymph of Dragon-fly (*Aeschnis grandis*), seen as two tubes immediately under the last pair of growing wings. × about 30.

FIGURE 421. Abdominal tip of nymph of Dragon-fly (*Aeschnis grandis*). × about 30.

It is interesting to note that young nymphs of *Agrion puella* have the thoracic spiracles to a certain extent functional, and Dewitz supposed that the muscular apparatus for inspiration by the spiracles was not fully developed, and this explains to some degree why these spiracles cannot be made full use of, and only used in a small degree.

In older nymphs of *Agrion puella* the spiracles do become wholly functional, and the nymphs can be observed to creep up plant stems, head foremost, throwing the body into a horizontal position when the surface of the water is reached, to expose the spiracles to the air. Though the spiracles are often used during at least the later part of the nymph's life, they cannot, of course, be employed when the nymph is actually submerged; hence other means of respiration are required in addition to that obtained by the spiracles.

Thus the nymph of *Agrion puella* has at its tail-end the three leaf-like appendages known as "caudal lamellae" (see Figure 418), and these are closely connected with the tracheal system. They extract air from the water, and the nymph breathes by means of them; further, they are of great service in swimming.

Each lamella or leaflet is ramified by a network of air tubes, which extract oxygen from the dissolved air contained in water, and pass this oxygen forward to the main tracheae, which in turn supply the chief organs of the body.

In other species of nymph the abdomen ends in five valves, three of which are commonly larger than the others, and can be brought to a point or widely separated (see Figure 421). When open they disclose the outlet of the main intestine guarded by three fleshy folds, corresponding to the three valves: within them is a large chamber (the rectum) the wall of which exhibits an extremely complicated structure.

Longitudinal bands are present, six in number, separated by thin and flexible membranes, which seem to be present to allow for great distension without risk of damage to the delicate epithelium or layer of the skin.

Each of these bands bears a double row of transverse folds, which increase the epithelial surface enormously, and at the same time the number of tracheal branches. The latter enter larger and more regularly arranged air-tubes, which again in turn open into the main trunks running the whole length of the body.

Large volumes of water are drawn into the rectum at intervals, and from these supplies the tracheal tubes draw the necessary amounts for respiration of oxygen from the air taken in. The vitiated water can either be expelled gently, or, when the nymph requires the body to be propelled forwards with considerable force, it makes use of this water.

The *Agrion puella* nymph has rectal gills like those of *Aeschna*, besides external gills. Thus we can observe the body swaying from side to side, whereas *Aeschna* nymphs come to the surface often, and take in air directly through the large intestine by means of the rectal opening. This can be seen to be carried out most frequently when the water is very foul. A stream of water does pass in and out of the rectum of *Agrion* nymphs, but there is no special apparatus present, as in *Aeschna*, to prevent the ingress of foreign particles, which would eventually close up the opening when sufficient had accumulated. If rectal respiration is made use of at all, it must be of minor importance, for in nymphs deprived of their lamellae contractions of the rectum do not take place.

Possibly, but not probably, respiration may be effected by air being taken in through the skin.

*(To be continued.)*

W. HAROLD S. CHEAVIN, F.M.S., F.E.S.

DEATH OF DR. M. C. COOKE.—Our readers will be sorry to hear of the death at Southsea on November 12th of this well-known authority and writer on botanical and natural history subjects, especially those in connection with the microscope. He was born on July 12th, 1825 (and was therefore in his ninetieth year), at a village in Norfolk. He was educated in the village school until he was nine, and then by his uncle, a dissenting minister. He was usher in a boys' school, afterwards clerk to a lawyer, and for nine years a certificated teacher in a national school. He had an appointment in 1860 to the India Museum, was transferred to Kew Gardens for botanical work, and was especially engaged in the Cryptogamic Department. He was M.A. (Yale, 1873), M.A. (St. Lawrence, 1870), LL.D. (New York, 1874), A.L.S. (1877), Gold Medal Linnean Society (1903), F.R.H.S., (1902), and was awarded the Victoria Medal of Honour by the Royal Horticultural Society. He was the author of over forty books on various botanical and natural history subjects. Among them: "Illustrations of British Fungi," in eight volumes with coloured plates; also an "Introduction to the Study of Fungi," 1895. His work on "British Freshwater Algae," with coloured illustrations, published 1882–4, and an "Introduction to Freshwater Algae," 1890, in the International Scientific Series, are probably more used than any other works in English on the subject. His work on Desmids and the "Handbook of British Fungi," 1871, though somewhat out of date, may still be considered standard works of reference. Many of his books are of a distinctly "popular" character, and, with papers innumerable and valuable contributed to various natural history societies, have done probably more to popularise natural history study, and especially that in connection with microscopy, than those of any other writer. In a recent letter to the Quekett Microscopical Club, of which he was one of the principal founders, he observed that he had made about fifteen thousand drawings of various natural objects for his books and other purposes. He was an honorary member of some fifteen scientific societies, British and foreign.

J. B.

THE QUEKETT MICROSCOPICAL CLUB.—The five hundred and first ordinary meeting of the Club was held at 20, Hanover Square, W., on Tuesday, October 27th. In the absence of the President, who had attended the meetings of the British Association in Australia, and had not yet reached England, the chair was taken by Mr. D. J. Scourfield, F.R.M.S., Vice-President.

After the formal business, additions to the Library and Cabinets since the five hundredth meeting were announced, the latter comprising sixty-one microscopic slides and two sets of physiological preparations, with descriptions. The thanks of the Club were accorded to the various donors.

The Chairman read a letter conveying the information of the death of Dr. Arthur Mead Edwards, of Newark, New Jersey, U.S.A. Dr. Edwards was the oldest honorary member, having been elected in January, 1868. He was then President of the American Microscopical Society of New York. At his death he was seventy-eight years of age. He was chiefly interested in the study of the Diatomaceae.

The report of Mr. C. F. Rousselet, F.R.M.S., delegate from the Club to the Conference of the Corresponding Societies of the British Association at Havre, was read by the Secretary. The Meeting began on Monday, July 27th, with an address of welcome by Mons. A. Gautier, the President, which was replied to by Sir W. Ramsey on behalf of the English members. There was a series of meetings for the rest of the week, with an excursion up the Seine as far as Rouen, visiting various historical places on the way. The success of the gathering, however, was interfered with by the critical state of political matters, and the Meeting was hurriedly broken up on Saturday on the promulgation by the French Government of the general mobilisation decree.

A paper by Mr. A. A. C. Eliot Merlin, F.R.M.S., was read (in part) on "The Minimum Visible." It commenced with a reference to the address of the President of the Club at the annual meeting, in which a point was raised respecting

XUM

the size of the smallest particles that can be seen with the microscope. Reference was also made to a paper, recently given at the Club on "Some Notes on the Structure of Diatoms," in which "pores" had been described as occurring on the valves of certain diatoms, estimated to be about 1/200000th of an inch in diameter. It stated: "As our knowledge is very exact and definite indeed on this subject, it may prove of interest to deal with the question in some detail. As a matter of fact, when a particle properly illuminated is just visible with a given objective, if the aperture be cut down by means of an iris diaphragm, placed above the back lens, so that the particle just ceases to be visible, and the N.A. to which the objective has been reduced is measured, then the dimensions of the particle can be exactly ascertained from the Antipoint Table, published by Mr. Nelson in the *Journal of the Royal Microscopical Society*." The paper was of a very valuable but technical character, and does not lend itself to an efficient summary, but will be reproduced in full in the next issue of the *J.Q.M.C.* Messrs. Brown, Blood, and Ainslie made some remarks on the subject, and a very hearty vote of thanks to Mr. Merlin was accorded.

Mr. Rousselet exhibited under microscopes two species of African volvox, showing the sexual state, and a short paper was read, detailing the remarkable history of their discovery. The identical species had been described from specimens showing the vegetative condition only, by Professor West, some time ago at the Club, but the sexual state of neither had then been found. Subsequently Mr. Rousselet had discovered these among other plankton organisms in some tubes sent to him by Professor Jakubski, of Lemberg, and which had been collected from another part of Africa. By this means the complete descriptions of the two species, *Volvox africanus* and *V. Rousseleti*, had been made good from a quite unexpected source.

Mr. W. E. Watson Baker exhibited under a microscope a mounted specimen of the egg and very young larva of the Anopheles mosquito. The organism is rarely found in these conditions. A vote of thanks was passed to both Mr. Rousselet and to Mr. Baker for their exhibits.

J. B.

## PHOTOGRAPHY.

By EDGAR SENIOR.

DEVELOPMENT WITH FERROUS OXALATE.—The method of development in which organic iron salts are employed was originally introduced by Mr. Carey Lea and Mr. W. Willis, junr., in 1877; and, although the method was never used to any great extent in this country, it was largely employed both on the Continent and in America for the development of exposed plates, while at the same time it was practically the only developer available for use with bromide papers until the advent of amidol and some of the newer developers. A considerable amount of attention has lately been drawn to its employment for this latter purpose, in case of any difficulty arising with regard to the supply of amidol, or any great increase in its cost, since ferrous oxalate can be prepared quite easily and cheaply by the photographer himself, the potassium oxalate being the most expensive of the constitutents used. Development with ferrous oxalate consists in applying to the exposed plate or bromide paper a solution of ferrous oxalate in potassium oxalate, since the ferrous salt itself is a lemon-coloured powder which is almost insoluble in water, but soluble in a solution of neutral potassium oxalate, producing a deep-red coloured liquid. In the preparation of the developer the neutral potassium oxalate must be employed, as the acid oxalate, known as salts of sorrel, would require its oxalic acid to be neutralised by means of potassium carbonate before it would be available for use. The method which was originally adopted in the formation of the oxalate developer consisted in the addition of ferrous oxalate to a warm and saturated solution of neutral potassium oxalate, the oxalate being added until a small portion of the ferrous salt remained undissolved, as by this means the ferrous oxalate developer was obtained in its most concentrated form. Another method due to Sir William Abney consisted in adding the ferrous oxalate to a cold, saturated solution of potassium oxalate, and allowing the mixture to remain, with occasional shaking, for twenty-four hours, when the clear liquid was decanted off for use. A method, however, which was first introduced by Dr. Eder consisted in mixing together three parts of a cold, saturated solution of potassium oxalate with one part of a solution of ferrous sulphate of the same strength. The addition of various foreign substances to the oxalate developer has also been recommended at various times, but the one found most useful, especially in portraiture, was that in which a few drops of a solution of "hypo" of the following strength was added:—

| | |
|---|---|
| "Hypo" ... ... ... ... | 1 part |
| Water ... ... ... ... | 200 parts |

(*To be continued.*)

## PHYSICS.

By J. H. VINCENT, M.A., D.Sc., A.R.C.Sc.

THE *X*-RAY SPECTROMETER.—The instrument employed in such investigations as the preceding is described in an illustrated article in *Nature* for October 22nd, 1914. The object of the *x*-ray spectrometer is to determine $\theta$ in any given case. If the *x*-rays are kept of the same wave-length $\lambda$, then the space $l$ between the planes rich in atoms can be compared together for different directions in the same crystal and for various crystals; and, if $\lambda$ be known, then $l$ can be computed. If, however, the crystal face employed be unchanged the wave-lengths of rays from different anticathodes can be found. The new instrument has parts corresponding to those of an ordinary spectrometer. As a source of radiation the anticathode of an *x*-ray tube is used. The anticathode is set at right angles to the cathode stream, and is presented almost edgeways to the direction of a slit, which admits the *x*-rays on to the crystal face. The source and slit correspond to the collimator of an ordinary spectroscope. The crystal is mounted on the rotating central table of the instrument with the face to be studied placed vertically. The line of the central axis of the spectrometer passes through this crystal face, and a vernier attached to the table records its position. The reflected *x*-rays pass from the crystal into the ionisation chamber, which corresponds to the telescope of an ordinary spectrometer, and is similarly provided with a vernier to read its position.

The ionisation chamber is an insulated metal vessel containing some heavy gas. An internal electrode is connected by an insulated and shielded wire to a gold leaf electroscope. The chamber is kept electrically charged, and when the reflected *x*-rays enter the chamber, and make the contained gas conduct, the gold leaf indicates their presence by its motion. Since the electroscope with its observing telescope and illuminating arrangements must be kept still, the connection with the electrode in the ionisation chamber is made at a point on the downward prolongation of the central axis of the spectrometer; so that when the chamber is swung round into different positions the connecting wire is not disarranged.

CAN THE RARE GASES BE PRODUCED BY ELECTRIC DISCHARGE?—In 1913 Collie and Patterson described experiments which seemed to show that when hydrogen at low pressure was subjected to the action of the electric discharge neon was produced. This experiment, however, yielded negative results when tried by Strutt, who could detect no trace of either neon or helium in his apparatus. Two papers on this subject appear in the *Proceedings of the Royal Society* for August 1st, 1914. In the first Merton finds that, if leakage of air into the tubes

FIGURE 422. The Penguins' Promenade at Cape Adare.

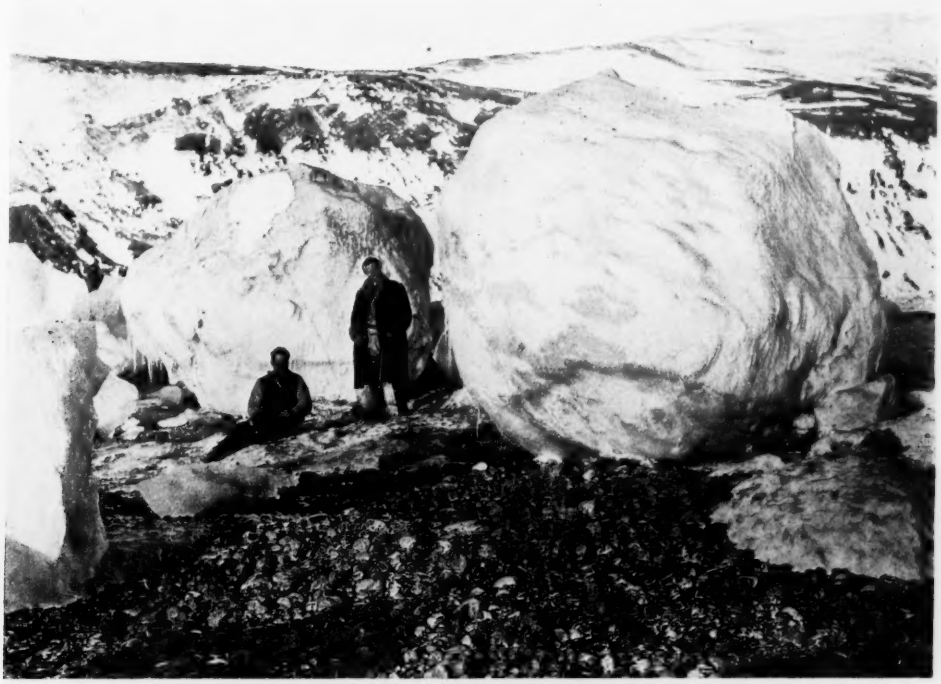


FIGURE 423. Ice Boulders hurled up the beach by a heavy swell.

(See page 440.)

(From "Antarctic Adventure," by Raymond E. Priestley. By the courtesy of Mr. T. Fisher Unwin.)

FIGURE 424. The female Slow-worm on the right side of the picture is laying her third egg. On the left is a young Slow-worm emerging from the first egg laid.

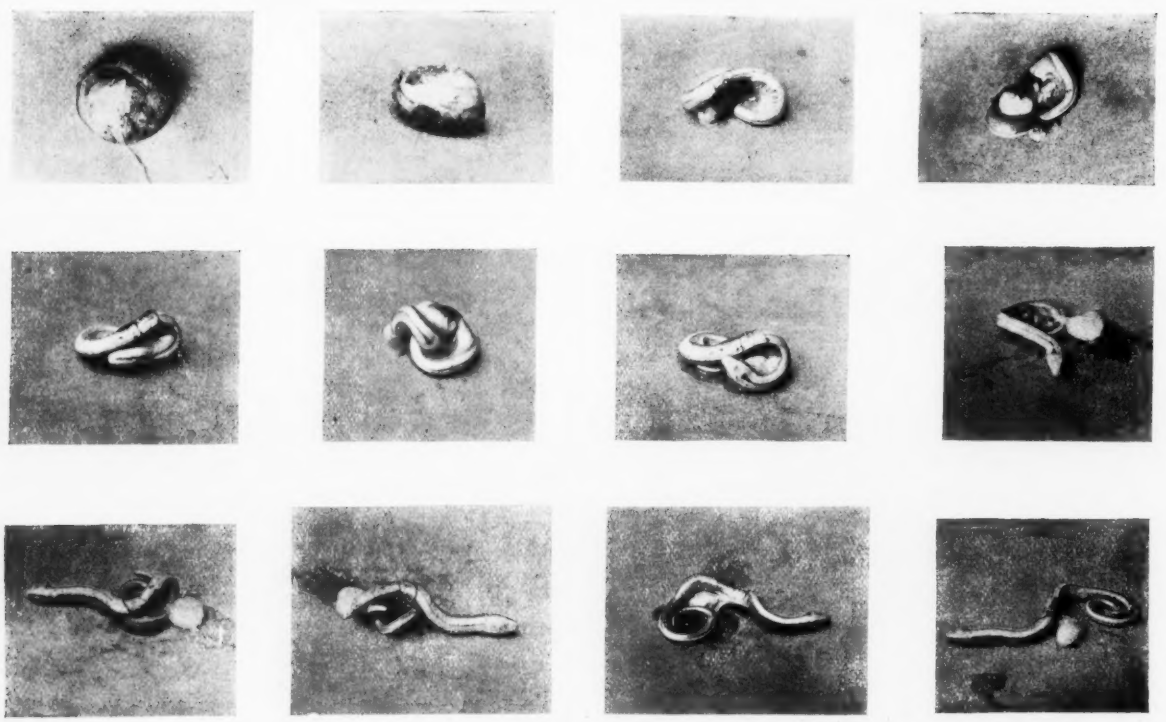


FIGURE 425. A series of twelve pictures showing a young Slow-worm freeing itself from the egg-membrane.

The Hatching of a Slow-worm's Egg. By the courtesy of the Editor of *Wild Life*.

is prevented, then no rare gases are found, and attributes the presence of argon in some experiments to this cause. In the second paper Collie studies the effect of the bombardment of uranium by cathode rays in hydrogen, and finds that, under certain conditions, the gases neon, helium, with a minute trace of argon are present. The subject is still under experiment, and one can only suspend judgment until some crucial test has been applied.

## RADIO-ACTIVITY.

By ALEXANDER FLECK, B.Sc.

SOURCES OF RADIUM.—For a long time after the discovery of radium the principal source of that valuable element was the small town of Joachimstal, in Bohemia, where the Austrian Government has a uranium factory. There are mines near there producing pitchblende; but the "dump" heaps, where the residues obtained in the purification of uranium had for years been placed, are of much greater value. The amount of radium that could be produced annually from this locality is not known, but, at any rate, the European war will have cut off this country from that source at present. Pitchblende has also been found in Cornwall; but there, again, working the refuse heaps seems to be of more commercial value than mining the mineral.

Autunite, a mineral composed of uranium phosphate, has never been found in quantities sufficiently large or concentrated to enable commercial work to pay. This remark applies to the material found in the north of Portugal, as well as to that found in the type locality of Autun, in France. Uranium minerals have been found at various parts of the world, but, with the exception mentioned below, all of them have been found in either too low grade or else in too small quantities. The exception referred to is carnotite, which comes from Colorado. It is a mineral containing uranium, potassium, and vanadium, and the main quantity occurs as the coating of the grains of an almost horizontally bedded sandstone. The mineral, however, is not found uniformly distributed throughout the sandstone, but occurs in "splashes" alternating with barren rock. This field, which is said to occupy a circular area of about one hundred and fifty miles in diameter, and includes part of Utah, seems destined to take an important place in the world's production of radium.

## ZOÖLOGY.

By PROFESSOR J. ARTHUR THOMSON, M.A., LL.D.

HIBERNATION OF MEADOW JUMPING MOUSE.—Dr. H. L. Babcock has made some observations on ***Zapus hudsonius***, the Meadow Jumping Mouse of Massachusetts. A captive specimen, which seemed to grow fat towards the end of summer, began, from August 28th onwards, to remain indoors intermittently when the nights were becoming cold. On November 1st it retired for the winter, but was found dead when the nest was opened in June. It probably died of cold, for it had made its nest in the side of a large sod placed in one corner of the cage, though it might easily have found a less-exposed situation. The observations made during the period before returing to rest seem to show that the torpidity comes on gradually—at first for only a night at a time—and that temperature is not the only factor affecting the onset of the hibernation.

KING SALMON IN FRESH WATER.—We notice in a recent report on the endoparasites of Kamtschatka Salmonidae a circumstantial confirmation of the statement that the species of Oncorhynchus, or Pacific King Salmon, do not eat in freshwater, and exhibit degeneration of the food canal. As is well known, the King Salmon ascend the rivers only once, usually in their third or fourth year, and die after spawning. There is no return to the sea as in the case of our Salmon. But it was the precise statement in regard to the alimentary tract that interested us: "The intestine and the stomach shrivel up, and the mucous membrane degenerates."

LIMPET'S FEEDING HABITS.—Dr. J. H. Orton has published an interesting figure, which shows a Limpet on its "home," and radiating from this a number of food-paths which it had eaten in a growth of green algae (chiefly young Enteromorpha) on a cement pile. The paths are marked by fine lines made by the teeth of the radula. In several cases, as the figure shows, the Limpet had evidently travelled beyond the end of the path formerly eaten before beginning to browse again, and had yet returned to its home in safety. In some cases the spatting of acorn-shells (*Balanus balanoides*) along the otherwise bare paths makes them so evident that they are easily seen from some distance away.

## *WILD LIFE.*

As foreshadowed in our notice of some months ago, the recent numbers of *Wild Life* have not consisted of so many pages, but the material which they have contained in no way falls short of the standard which has been set in the past. The September number practically consists of notes and photographs of the kingfisher in the many aspects of its daily life. In the October number a special feature is made of British reptiles, and photographs of all the species by Mr. Douglas English are given. By kind permission we reproduce the illustrations showing the egg-laying of the blindworm and the almost immediate hatching of the egg (see Figures 424 and 428). Careful drawings of this were given in "Eton Nature Study", in 1903, but we do not think that photographs of this interesting occurrence have been successfully taken and reproduced before. The same number contains an article on the Grey Lag Goose, and in the issue for December Mr. Russell Roberts will conclude his remarks on the black rhinoceros. There will also be articles on the raven, the hare, the pied wagtail, and British clear-wing moths, with the usual notes from the Zoölogical Gardens, which are contributed by Mr. E. G. Boulenger.

## REVIEWS.

### CHEMISTRY.

*Some Fundamental Problems in Chemistry: Old and New.* —By E. A. LETTS, D.Sc. 235 pages. 44 illustrations. 9-in. × 6-in.

(Constable & Co. Price 7/6 net.)

The object of this book is to link up the chemical theories of the last century with those that have followed the discovery of the inert gases and the disintegration of the radio-active elements. The material for such a survey is ample, for many of the discoveries of to-day are now seen to have been foreshadowed, although dimly, in the observations put forward in support of theories now discarded. The new chemistry, too, can claim the fulfilment of prophecies, and the prediction of the discovery of the gas neon is as striking as Mendeléef's prediction of unknown elements to fill gaps in the periodic table.

Dr. Letts tells this story of the evolution of chemistry into its present position in a simple manner, which holds the attention of the reader from the outset. The subjects

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discussed include the periodic law, the transmutation of elements under the influence of radio-activity, Sir Norman Lockyer's views on inorganic evolution, and the theory of Arrhenius upon the sources of the energy of the Sun. Some idea of the extent of the ground covered may be gathered from the fact that room is found for a description of the construction of the micro-balance.

It is a book to be read more than once by every chemist or everyone interested in chemistry.

*Chemistry and its Borderland.*—By A. W. STEWART, D.Sc. 314 pages. 15 illustrations. 8-in. × 5½-in.

(Longmans, Green & Co. Price 5/- net.)

The scope of this book is very wide, for it gives in a semi-popular form, devoid of formulae, a comprehensive survey over the whole field of modern chemistry. Thus separate chapters are given to immuno-chemistry, chemistry in space, colloids and the ultra-microscope, radium, transmutation, methods of chemical research, and so on. The author is exceptionally successful in making any abstruse points clear, and each subject is treated in such a way that even those whose knowledge of chemistry is of the slightest can follow it easily and with pleasure. Throughout the book we feel that we are reading, not merely a narrative, but that there is also a point of view in the background.

The last chapter, which deals with suggestions for organising chemical research, is interesting, and likely to promote discussion. It is chiefly concerned with the teaching institutions in this country, and rather conveys a suggestion of deprecating the good research work that has been done in connection with industrial problems. A good deal depends upon what is to be regarded as the object of research. If it is mental training, the problems to be solved in the factory may be quite as effective as the preparation of synthetic compounds. Nor do the methods of the teaching institutions necessarily promote any greater originality of thought. The aim is frequently to score well in examination, and many students, after an academic training, are little, if anything, better than the "human testing machines" of the factory. The Institute of Chemistry is doing much to remove the stigma of incompetence from the utilitarian chemist, and in its examinations it endeavours to discover the capacity of a student for original work, and to give him credit for what he has done. It is somewhat strange that Dr. Stewart should have omitted any mention of the work of the Institute; since it is the one body that aims at promoting the efficiency of the chemist, both from the academic and the more narrowly professional point of view.

C. A. M.

## PHYSICS.

*Report of the National Physical Laboratory*, 1913–14.—144 pages. 5 plates. 1 figure. 10½-in. × 8-in.

(Teddington: W. F. Parrot. Price 2/.6)

This report gives a concise statement of the activities of the laboratory for the period of fifteen months, beginning with January 1st, 1913. So condensed an account of the diverse work of this great institution does not lend itself readily to further compression. The routine tests carried out during the year involved the receipt and dispatch of goods to the value of £300,000. The total annual expenditure is about £40,000, three-quarters of this sum being spent in salaries, wages, and so on. It is a remarkable fact that, in spite of the large amount of commercial testing which is carried out, the scientific work of the laboratory is not only of the highest type, but of great volume. The list of papers published by the staff since 1912 occupies nearly nine pages, and includes many memoirs of the first importance. The Director (Dr. Glazebrook, F.R.S.) acknowledges his indebtedness to the heads of departments for the various sections of the report. Both he and they are to be congratulated on their work, and the nation, as a whole, has every cause to be proud of its youthful, vigorous, and rapidly growing physical laboratory.

J. H. V.

## POLAR EXPLORATION.

*Antarctic Adventure.* Scott's Northern Party.—By RAYMOND E. PRIESTLEY. 382 pages. 1 map. 150 illustrations. 9-in. × 5¾-in.

(T. Fisher Unwin. Price 15/- net.)

When, during his last antarctic expedition, Captain Scott started on his journey to the Pole, he left behind him a "Northern Party" to explore and to make scientific observations. The members of this party were: Commander Campbell, Surgeon Levick, who was zoölogist and photographer, three men, and Mr. R. E. Priestley, who acted as geologist and meteorologist. The last it is who has written the trenchant account which is before us of their doings. They were landed at Cape Adare, where stores were put ashore for them and a hut erected, which they were left to finish. The first part of the narrative deals with the year which they spent at this spot. The difficulties which had to be overcome in photography, when, in early days, they handled water and developers in a disused hut, where the temperature was ten degrees below freezing, could not be guessed from the many excellent illustrations with which the book is adorned. Two of these we are permitted to reproduce in Figures 422 and 423.

Mr. Priestley comments on the volunteer help which he received, and gives credit to the men, Abbott, Browning, and Dickason, for much of the scientific work accomplished. He says that the Northern Party, arriving in the Antarctic with five sailors and one scientist, may be fairly said to have returned with six scientists, all of whom had done original work in one department or another.

After a time the "Terra Nova" took the party down the coast, and left them to make a sledging expedition. Unfortunately she was unable to return, and the winter had to be faced with practically no equipment and insufficient provisions. The second part of the volume deals with the trials of the six men, and how they successfully came through them.

W. M. W.

# NOTICES.

MR. A. W. ISENTHAL, who is the sole partner in Messrs. Isenthal & Co., has been resident in this country for twenty-five years, and is a naturalised British subject. The business is carried on without any outside financial assistance, British or foreign, and the whole of the firm's workmen and works staff consists of British-born subjects. The foreign patents which they exploit at present are of Swiss origin.

THE WELLCOME RESEARCH LABORATORIES.—Dr. Frederick B. Power has retired from the directorship of the Wellcome Chemical Research Laboratories in order to return to the United States of America, where, for family reasons he will make his future home. His period of service dates from the foundation of the laboratories by Mr. Henry S. Wellcome in the spring of 1896. Dr. Power has been succeeded by Dr. Frank L. Pyman.

LONDON NATURAL HISTORY SOCIETY.—The Council of the London Natural History Society invites any Belgian or French refugees interested in natural history to attend the Society's meetings, and offers them the use of the Society's library and collections. The meetings of the Central Society are held at Hall 20, Salisbury House, London Wall, E.C., at 7 p.m., on the first and third Tuesdays of the month. Further particulars can be obtained from J. Ross, 18, Queen's Grove Road, Chingford, N.E.

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